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Study of the Feasibility of Integrating Information from Existing Airport Security Data Sources

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by

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16. Abstract

The purpose of this feasibility study was to:

- Identify the various sources of passenger-related security information;
- Quantify the screening information; and
- Determine whether the information could be fused in an integrated presentation to enhance passenger security screening.

This study examined various existing or soon to be deployed airport security equipment types and systems. Data was acquired from most of the manufacturers and they provided technical manuals and documents about equipment interfaces and their interaction with external controls or systems. Other sources were used to obtain data not readily available from the manufacturers' technical manuals, such as Web sites, FAA reports, ICAO documents, IATA documents, and government (American and Canadian) documents.

The study results indicated that every piece of security equipment has interfaces that can be accessed to retrieve the video/picture data or the detection of an alarm condition for the security database application. However, each manufacturer of airport security equipment has a different way of communicating with its systems. Nevertheless, this study has shown the feasibility of linking most airport security equipment and systems to an airport security system database.

Recommendations from this study are:

- Any new checked baggage and carry-on baggage X-ray screening equipment should have an interface available for data and image input/output.
- Video imaging should be added and linked to the Airport Security Data Fusion system at the following locations: ticket counter, passenger check-in counter, passenger screening points, and aircraft boarding gates.
- A small-scale version of a full-featured airport security system database application should be limited initially to: passenger check-in counter, passenger screening points, and aircraft boarding gate.

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16. Résumé

Le but de l'étude de faisabilité était de :

- répertorier les diverses sources d'information de sécurité concernant les passagers,
- quantifier les informations fournies par le filtrage,
- déterminer si les informations peuvent être fusionnées et présentées dans un ensemble intégré afin d'améliorer le filtrage de sécurité des passagers.

L'étude a examiné divers types de dispositifs de sûreté aéroportuaire et systèmes connexes déjà en service ou qui le seront bientôt. La plupart des fabricants ont participé à la collecte des données, fournissant leurs manuels et documents techniques concernant les interfaces des dispositifs et leurs interactions avec les systèmes ou les commandes externes. D'autres sources ont été consultées, telles que des sites Web, des rapports de la FAA, des documents de l'OACI et de l'IATA, et des documents des gouvernements canadien et américain, afin de compléter les données des manuels techniques des fabricants.

Les résultats de l'étude ont révélé que tous les dispositifs de filtrage sont dotés d'interfaces auxquelles on peut accéder pour extraire la donnée vidéo/l'image ou la détection d'une situation d'alarme et la transférer dans la base de données de sécurité. Mais chaque fabricant de matériel de sûreté aéroportuaire a sa propre façon de faire communiquer ses systèmes. L'étude a néanmoins montré la faisabilité de relier la plupart des matériels et systèmes de sûreté aéroportuaire à une même base de données.

Voici les recommandations formulées à la suite de cette étude :

- Tous les nouveaux dispositifs de détection aux rayons X pour les bagages enregistrés et les bagages à main devrait être assortis d'un périphérique d'entrée-sortie de données et d'images,
- L'imagerie vidéo devrait être reliée au système de fusion des données de sécurité aéroportuaire aux endroits suivants : billetterie, comptoir d'enregistrement des passagers, points de contrôle des passagers et portes d'embarquement,
- La mise en service d'une version à échelle réduite, mais dotée de toutes les fonctions prévues, d'une base de données du système de sécurité aéroportuaire, devrait être limitée, au départ, à ces endroits : comptoir d'enregistrement des passagers, points de contrôle des passagers et portes d'embarquement.

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Executive Summary

This project was initiated in response to a request by Transport Canada to study and report on the feasibility of integrating security equipment information from existing airport security equipment or systems.

The Canadian and U.S. governments participate in a joint multi-year R&D initiative to develop security screening technology. Although this initiative over the past few years has concentrated on the ability to detect and identify explosive materials in carry-on/checked baggage, it is now moving toward the integration of this information with other data from complementary screening equipment, for instance, X-ray image data. A barrier to successfully integrating these data has been the proliferation of security equipment with varying degrees of integration capability.

A lack of communication among security devices exists at airports, along with a general inability to relate baggage to passengers or trace it through the facility without sending a security person. Airport security relating to passengers could be more effective than present-day implementations if the data from the various sensors and input devices could be integrated or fused and presented to an operator.

The purpose of this study was to:

- Identify the various sources of passenger-related security information;
- Quantify the screening information; and
- Determine whether the information could be fused in an integrated presentation to enhance passenger security screening.

This feasibility study examined various existing or soon to be deployed airport security equipment types and systems. Data were acquired from most of the equipment manufacturers and they provided technical manuals and documents about equipment interfaces and their interaction with external controls or systems. Other sources were used to obtain data not readily available from manufacturers' technical manuals, such as Web sites, FAA reports, ICAO documents, IATA documents, and government (American and Canadian) documents available publicly. This report lists all of the systems and equipment investigated. The data have been tabulated in Excel spreadsheets and are described in text form and in pictures.

The results indicated that no single, convenient interface on any of the screening security equipment or systems can communicate to other systems from other manufacturers. Each manufacturer of airport security equipment has a different way of communicating to its systems. Even different systems from the same manufacturer cannot exchange data or communicate with one another or with some common control system.

The results of this study show that linking most of the airport security equipment and systems to an airport security system database is feasible. This could be accomplished by designing and developing interface units that can adapt the available data interfaces, data protocols, and data formats to a single common interface without affecting the operation or functions of the systems already deployed. Once these interfaces have been developed for the airport security equipment and systems, such as baggage X-ray scanners, passenger screening equipment, airline reservation terminals, and boarding gate terminals, the data from many of these systems could be used to enhance the level of security at airports.

The study makes the following recommendations:

- Any new checked baggage equipment, carry-on baggage X-ray screening equipment, and passenger screening equipment should have an interface available for data and image output. This interface should be able to work in several modes of data I/O to a common digital data format and to a physical LAN interface. This interface should be defined for both the physical and the data structure and protocol formats. This standard, when developed and implemented, would permit a central database to query or receive broadcast mode data from these systems and the server would be able to determine what needs to be done with this data.

  Such an interface and protocol standard would permit all future checked baggage X-ray machines and carry-on X-ray machines to transfer image data to a central database for applications such as Airport Security Data Fusion (ASDF) or other related functions. Passenger scanning equipment would be able to transmit the results of a scan to a central ASDF database without further processing. This capability, if implemented, would create an open system architecture for communications and permit various manufacturers to transfer data to third-party equipment and systems.

  This proposed standard should be defined following the ISO 7 Layer Reference Model (or ***ISO Reference Model of Open Systems Interconnection***). In this approach, all of the required data and protocol functions can be defined and referred to common approaches and definitions.

  If implemented, this recommendation would permit future systems integration without extensive requirements for interface hardware and custom modules that may need to be retrofitted.

- Video imaging should be added to the following locations:

  – ticket counter;
  – passenger check-in counter;
  – passenger screening points; and
  – aircraft boarding gates.

  This would allow confirmation of the behaviour and identity of a passenger and linkage of this information to other security data. With digital video imaging and recording of passengers checking in, clearing passenger screening, and boarding the aircraft, identities can be determined and confirmed by either real-time processing or by post-event analysis.

- A reduced-scale version of a full-featured airport security system database application should be limited initially to:

  – passenger check-in counter;
  – passenger screening points; and
  – aircraft boarding gates.

Sommaire

Ce projet a été lancé à la demande de Transports Canada dans le but d'étudier la faisabilité d'intégrer les informations recueillies par les dispositifs ou systèmes de sûreté en place aux aéroports.

Les gouvernements canadien et américain participent à un projet pluriannuel de R&D visant à développer la technologie du filtrage de sûreté. Bien que ces dernières années, on se soit concentré sur la capacité à détecter et à identifier les explosifs dans les bagages à main et les bagages enregistrés, il s'avère maintenant nécessaire d'intégrer l'information recueillie à cet égard aux données fournies par d'autres matériels complémentaires, notamment les données obtenues par radioscopie. L'obstacle à une intégration réussie des données est la prolifération des dispositifs de sûreté ayant des capacités d'intégration variables.

Les dispositifs de sûreté d'un aéroport communiquent difficilement entre eux, ils sont incapables d'apparier les bagages à leurs propriétaires ou de les retrouver dans le terminal sans que soit dépêché un agent de sécurité. Le contrôle de sécurité des passagers dans les aéroports pourrait être plus efficace qu'il l'est actuellement, si les données provenant de plusieurs capteurs et unités d'entrée pouvaient être intégrées ou fusionnées, puis présentées à un opérateur.

Le but de l'étude était de :

- répertorier les diverses sources d'information de sécurité concernant les passagers,
- quantifier les informations fournies par le filtrage,
- déterminer si les informations peuvent être fusionnées et présentées dans un ensemble intégré afin d'améliorer le filtrage de sécurité des passagers.

L'étude de faisabilité a examiné divers types de dispositifs de sûreté aéroportuaire et systèmes connexes déjà en service ou qui le seront bientôt. La plupart des fabricants ont participé à la collecte des données, fournissant leurs manuels et documents techniques concernant les interfaces des dispositifs et leurs interactions avec les systèmes ou les commandes externes. D'autres sources ont été consultées, telles que des sites Web, des rapports de la FAA, des documents de l'OACI et de l'IATA, et des documents des gouvernements canadien et américain, afin de compléter les données des manuels techniques des fabricants. Le rapport énumère tous les systèmes et matériels étudiés. On trouve les données mises en forme à l'aide du tableur Excel, commentées, et représentées par des figures.

Les résultats de l'étude ont démontré qu'aucune des interfaces équipant l'un ou l'autre des dispositifs ou systèmes de filtrage de sûreté ne peut communiquer avec les systèmes des autres fabricants. Chaque fabricant de matériel de sûreté aéroportuaire a sa propre façon de faire communiquer ses systèmes. Même des systèmes différents provenant d'un même fabricant ne peuvent communiquer entre eux ou avec un même système de commande.

Les résultats de l'étude révèlent qu'il est possible de relier la plupart des matériels et des systèmes de sûreté d'un aéroport à une même base de données. Pour y parvenir, il suffirait de concevoir et de développer des modules d'interfaçage pouvant rattacher les interfaces existantes, les protocoles et les formats de données à une seule interface commune, sans que les opérations ou les fonctions des systèmes ne soient touchées. Lorsque de telles interfaces équiperont les systèmes et matériels de sûreté de l'aéroport (systèmes de détection par rayons X, dispositifs de filtrage des passagers, terminaux de réservation, terminaux aux portes d'embarquement), les données provenant d'un bon nombre de ces systèmes pourront être utilisées pour augmenter le niveau de sécurité dans les aéroports.

Voici les recommandations formulées à la suite de l'étude :

- Tous les nouveaux matériels de contrôle des bagages enregistrés, matériels de détection aux rayons X pour les bagages à main et dispositifs de filtrage pour passagers devront être assortis d'interface de sortie de données et d'images. L'interface devra être en mesure de traduire plusieurs types d'entrées/sorties en un format numérique commun et de les intégrer dans un réseau local physique. L'interface devra être définie en fonction de la structure matérielle et logicielle du réseau, ainsi que des formats des protocoles. Lorsque cette norme aura été élaborée et mise en oeuvre, il sera possible pour une base de données centrale d'interroger ces systèmes ou de recevoir les données en mode diffusion. Le serveur sera capable de déterminer la façon de traiter ces données.

  Grâce à cette interface et ce protocole normalisés, les prochains appareils de vérification aux rayons X des bagages enregistrés et des bagages à main pourront transférer les images à une base de données centrale aux fins d'applications telles que la fusion des données de sécurité aéroportuaire (FDSA) ou pour toute autre fonction connexe. Les dispositifs de contrôle des passagers pourront transmettre tels quels les résultats d'une radioscopie à une base de donnée centrale FDSA. Cette interface, si elle est implantée, créera une architecture de systèmes ouverts pour les communications. Elle permettra aussi l'échange de données entre matériels de différents fabricants.

  La norme proposée devra être définie selon le modèle de référence OSI organisé en sept couches (ou **modèle de référence de l'interconnexion de systèmes ouverts ISO**). Selon cette approche, toutes les données et les protocoles nécessaires peuvent être définis en fonction de règles et de définitions communes.

  La mise en oeuvre de cette recommandation facilitera l'intégration ultérieure de systèmes, sans entraîner de lourds besoins d'adaptation des interfaces et des modules personnalisés.

- L'imagerie vidéo devrait être installée aux endroits suivants :

  – billetterie,
  – comptoirs d'enregistrement des passagers,

– points de contrôle des passagers,
– portes d'embarquement.

Cette technique permettra de confirmer l'identité ainsi que le comportement d'un passager et de relier l'information à d'autres données de sécurité. Grâce aux images et aux enregistrements numériques des passagers en train de s'enregistrer, de franchir le point de contrôle et de monter à bord de l'avion, il sera possible de déterminer et de confirmer l'identité d'une personne soit en temps réel ou après coup.

- La mise en service d'une version à échelle réduite, mais dotée de toutes les fonctions prévues, d'une base de données du système de sécurité aéroportuaire devrait être limitée, au départ, à ces endroits :

– comptoirs d'enregistrement des passagers,
– points de contrôle des passagers,
– portes d'embarquement.

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Glossary of Abbreviations, Acronyms, Symbols, and Special Terms

10BaseT	*Ethernet.* The most common form of Ethernet is called 10BaseT, which denotes a peak transmission speed of 10 mbps using copper twisted-pair cable. Ethernet is a standard for connecting computers into a local area network (LAN).
100BaseT	*Fast Ethernet.* 100BaseT is another term for fast Ethernet, an upgraded standard for connecting computers into a local area network (LAN). 100BaseT Ethernet works just like regular Ethernet except that it can transfer data at a peak rate of 100 mbps.
AAAE	*American Association of Airport Executives* is a professional organization representing airport management personnel at public use airports nation-wide.
ABC	*Automated Boarding Control*
ACI-NA	*Airports Council International-North America.* ACI-NA represents airport operators who operate about 1,250 airports across 155 countries and Territories.
Advanced X-ray	Differentiates between organic and inorganic materials. Also, in some cases, the systems may have the added capability of automatically indicating the presence of explosive materials with colour video and/or an alarm.
AIP	*Airport Improvement Program*
AN	*Ammonium Nitrate.* Commonly used as fertilizer. When mixed with fuel oil, it becomes highly explosive.
ANSI	*American National Standards Institute*
ASDF	*Airport Security Data Fusion*
ASIC	*Application Specific Integrated Circuit.* An ASIC is an integrated circuit designed to address one particular application.
ATA	*Air Transport Association.* ATA is the trade organization for the principal US air carriers.
ATM	*Asynchronous Transfer Mode*
atto	*Number* 10^{-18} or symbol 'a'
AUI	*Attachment Unit Interface*
AWG	*American Wire Gauge*
BEDS	*Bulk Explosives Detection System* for checked Baggage Screening
BER	*Bit Error Rate*
CAPS	*Computer Aided Passenger Screening System*
Cat X	Large Airport that handles air traffic to/from international destinations. Main International Entry point for country such as JFK in New York or Newark in New Jersey or BWI at Baltimore Washington International Airport.
CCITT	*International Telegraph and Telephone Consultative Committee*
CCTV	*Closed Circuit Television*

CEC	*Canadian Electrical Code*
CES	*Circuit Emulation Service*
Chemical Particle	Uses various technologies to chemically detect the presence of minute particles of explosive materials.
Chemical Reaction	Uses chemicals to react with minute quantities of explosive materials to indicate (usually by changes in colour) presence of the explosive.
Chemical Vapour	Uses various technologies to chemically detect the presence of explosive vapours. Also detects particles.
Coax	*Coaxial Cable*
Conventional X-ray	Standard X-ray with pseudo colour display that enhances target density differences.
COSAC	*Canadian Open Systems Application Criteria*
CSA	*Canadian Standards Association*
CT	*Computed Tomography*
CTSCAN	*Computed Tomography Scan*
CSMA/CD	*Carrier Sense Multiple Access/Collision Detection* (IEEE802.3)
DATA I/F	*Data Interface*
DAVB	*Digital Audio Video Broadcast*
DoD	*Department of Defense (US)*
DoE	*Department of Energy (US)*
DoT	*Department of Transportation (US)*
DOT	*Department of Transportation (UK)*
DS-0	*Digital Service, level 0.* A world-wide standard speed of 64 kbps for transmitting PCM digitized voice signals.
DS-3	*Digital Signal Level 3.*A Transmission service at 44.736 Mbps.
DSP	*Digital Signal Processor.* A microprocessor optimized for signal processing applications, for example, the TMS320C25.
EGDN	*Ethylene Glycol Dinitrate.* A type of explosive material often used in dynamite.
EIA	*Electronic Industries Association*
EMI	*Electro Magnetic Interference*
Encry	*Encryption*
ER	*Equipment Room*
Ethernet	Precursor to, and almost identical to *IEEE802.3 Standard*
exa	*Number* 10^{18} or symbol 'E'
FAA	*Federal Aviation Administration (US)*
FDDI	*Fibre Distributed Data Interface*
FDMA	*Frequency Division Multiple Access*

FEC	*Forward Error Correction*
Femto	*Number* 10^{15} or symbol 'f'
FIT	*Failure Unit.* Failure Rate defined in failures per billion (10e^9) device-hours.
GAO	*General Accounting Office.* An office of the US Congress.
GI	*Graded Index* Fibre type wherein the core refractive index decreases almost parabolically radially outward toward the cladding
giga	*Number* 10^9 or symbol 'G'
GUI	*Graphical User Interface*
HMX	*Cyclotetra-methylene tetranitamine.* Trade name for a military explosive.
HneT	*Holographic/Quantum Neural Technology*
IATA	*International Air Transport Association*
IBRIS	*Interactive Baggage Reconciliation Information System*
IC	*Intermediate Crossconnect*
ICAO	*International Civil Aviation Organization*
ID	*Identification*
IEC	*International Electrotechnical Commission*
IED	*Improvised Explosive Device*
IEEE	*Institute of Electrical and Electronic Engineers*
ILD	*Injection LASER Diode.* A solid state semiconductor device consisting of at least one p-n junction capable of emitting coherent, stimulated radiation under specified conditions.
IMS	*Ion Mobility Spectrometry*
IBRIS	*Interactive Baggage Reconciliation Information System*
IP	*Information Provider*
ISA	*Industry Standard Architecture*
ISDN	*Integrated Services Digital Network*
ISO	*International Standards Organization*
IT	*Information Technology*
km	*Kilometre*
kilo	*Number* 10^3 or symbol 'k'
LAN	*Local Area Network*
LCD	*Liquid Crystal Display*
LED	*Light Emitting Diode*
Level 1	*Level 1* is a fully-automated Level 1 explosives detection system integrated into the existing airport baggage handling system to rapidly screen all baggage without an operator in attendance. Bags rejected by the Level 1 system are subjected to Level 2 inspection. Bags cleared (not rejected) by the Level 1 systems are accepted for loading onto the aircraft.

Level 2	*Level 2* inspection equipment allows an operator to review and manipulate images of the contents of the rejected bags provided by the Level 1 system or a separate Level 2 system. If the operator rejects the bag, it is forwarded for Level 3 inspection.
Level 3	*Level 3* inspection is the slowest and most detailed process. Bags rejected at Level 3 are then inspected by hand in the presence of the passenger. Bags not rejected at any inspection level are conveyed by the baggage handling system for loading into the aircraft.
LRU	*Line Replaceable Unit*
MAU	*Medium Attachment Unit*
Mbit/s	*Megabits per second*
mega	*Number* 10^6 or symbol 'M'
MHz	*Megahertz*
micro	*Number x* 10^{-6} or symbol 'µ'
milli	*Number x* 10^{-3} or symbol 'm'
MM	*Multi-Mode* Fibre, an optical fibre capable of carrying more than one mode of light in its core.
MOT	*Ministry of Transport*
MPEG	*Motion Picture Experts Groups*
MRI	*Magnetic Resonance Imaging*
MTBF	*Mean Time Between Failure.* The average time between predicted equipment or system breakdowns. Typically provided by product design engineering, calculated to reflect the theoretical hard failure rate using the sum of the individual components of an item or system.
MTTI	*Mean Time To Install.* The average time to initially bring a system to the specified operational level.
MTTR	*Mean Time To Repair.* The average time it takes to return an inoperative item or system to full functionality. Typically includes the time to diagnose symptoms, acquire parts, time to repair or replace, plus re-verification, return to operation, and maintenance reporting.
NA	*Numerical aperture.* The measure of light acceptance of a fibre.
nano	*Number x* 10^{-9} or symbol 'n'
NBC	*National Building Code*
Neutron Analysis	Thermal neutron analysis (TNA) and pulsed fast neutron analysis (PFNA). Similar to Magnetic Resonance Imaging (MRI) and Computed Tomography (CTSCAN).
NG	*Nitroglycerine* An explosive chemical used in dynamite
NI	*Network Interface*
NIC	*Network Interface Card*
NIST	*National Institute of Standards and Technology*
nm	*Nanometer*

NQR	*Nuclear Quadruple Resonance*
OIG	*Office of Inspector General*
OSI	*Open System Interconnection*
OTA	*Office of Technology Assessment.* A department of the U.S. Congress.
PBX	*Private Branch Exchange*
PC	*Personal Computer.* This generally describes a computer that is in a small physical chassis and is generally built around an Intel X86 or Motorola processor.
PCI	*Peripheral Component Interconnect*
PD	*Probability of Detection*
peta	*Number* 10^{15} or symbol 'P'
PETN	*Pentaerythritol Tetranitrate.* A primary ingredient in some bulk plastic explosives, (i.e. Semtex) and sheet explosives (i.e. Detasheet). Unusually low nitrogen density for a plastic explosive: 18 percent by weight.
PFA	*Probability of False Alarm*
PFNA	*Pulsed Fast Neutron Analysis*
pico	*Number x* 10^{-12} or symbol 'p'
PPBM	*Positive Passenger Bag Matching*
PSTN	*Postal Service Telephone Network*
PSU	*Power Supply Unit*
RDX	*Cyclotrimethylenetrinitramine.* Primary ingredient of military plastic explosives known as C-3 and C-4, 38 percent nitrogen by weight.
RE&D	*Research, Engineering, and Development*
R&D	*Research and Development*
RFI	*Radio Frequency Interference*
Rfu	*Reserved for Future Use*
RZ	*Restricted Zone.* Generally the passenger area at Canadian airports past the Passenger Screening area and before the boarding gate, with access to all boarding gates.
Schedule 1	*International Arrivals and Departures Airport.* Canadian designation for international departure and arrivals port of entry airport. Pearson International (Toronto) or Vancouver International.
Schedule 2	*Major Domestic Airport.* Canadian designation for major domestic airport such as MacDonald Cartier (Ottawa) Airport.
Schedule 3	*Regional Airport.* Canadian designation for regional airport such as Chicoutimi, PQ.
SDE	*Scatter Detection Enhancement* allows the detection of X-rays scattered from baggage that provide higher sensitivity to threats. Acquisition of the scatter signals is simultaneous with the conventional image information so that data from each can be matched and used in correlated algorithms.
SDS	*Structured Distribution System*

SI	*Step Index.* A fibre in which the core is of a uniform refractive index.
SM	*Single Mode.* A fibre wave-guide that supports the propagation of only one mode.
SNR	*Signal to Noise Ratio*
SQL	*Structured Query Language*
STP	*Shielded Twisted Pair*
TC	*Transport Canada*
TEDS	*Trace Explosives Detection System*
tera	*Number* 10^{12} or symbol 'T'
TIA	*Telecommunications Industry Association*
TNA	*Thermal Neutron Analysis*
TS0	*Time Slot Zero.* The first time slot in a CEPT frame. Part of this time slot can be used for CPSS messages.
UTP	*Unshielded Twisted Pair*
WAN	*Wide Area Network*

1 INTRODUCTION

1.1 Purpose

The purpose of this document is to present the current (c. 1999) capabilities of fielded airport passenger security equipment and to describe the extent to which the equipment can be networked to allow data integration and data fusion.

1.2 Objectives

The objectives of this project were to:

- Identify the various sources of passenger-related security information;
- Quantify the screening information; and
- Determine whether the information could be fused in an integrated presentation to enhance passenger security screening.

1.3 Scope

The scope of this report is limited to current fielded equipment only. It includes any information from equipment located at the check-in counter, the passenger screening area, the checked baggage screening area, and the boarding area.

1.4 Background

In March 1999, Transport Canada and the Technical Support Working Group (TSWG) for the US Secretary of Defense and the Solicitor General's Office of Canada agreed to participate in a multi-year R&D initiative to develop security screening technology. Although this initiative over the past few years has concentrated on the ability to detect and identify explosive materials in carry-on/checked baggage, it is now moving toward the integration of this information with other data from complementary screening equipment, for instance, X-ray image data. A barrier to successfully integrating these data has been the proliferation of security equipment with varying degrees of integration capability.

A lack of communication between security devices exists at airports, along with a general inability to relate baggage to passengers or trace it through the facility without sending a security person. Airport security relating to passengers could be more effective than present-day implementations if the data from the various sensors and input devices could be integrated or fused and presented to an operator.

1.5 Report Organization

This report is organized into sections as follows:

- Section1 – Introduction. This section gives the scope of the report and provides background data.
- Section 2 – Airport Passenger Security. This section discusses current policies and regulations relating to passenger security, the organizations involved in passenger security at airports, and the threat to passenger security.
- Section 3 – Security Equipment Types. This section presents the information garnered from vendors of airport security equipment and discusses their integration capability.
- Section 4 – ASDF System Concept. This section describes a design concept for an Airport Security Data Fusion system.
- Section 5 – Conclusions and Recommendations. This section presents conclusions and recommendations.
- Appendix A – Bibliography. This section presents the report bibliography.
- Appendix B – The Technology. This section presents a discussion of the basic technology.
- Appendix C – Interviews Conducted. This section presents a list of interviewees.
- Appendix D – Equipment Information. This section presents a detailed description of available equipment by vendor.
- Appendix E – Equipment Data Matrices. This section presents the ASDF equipment data as Excel spreadsheets listing equipment specifications and equipment interface data in matrix form.

2 AIRPORT PASSENGER SECURITY

2.1 Introduction

This section presents and discusses the various aspects of airport and air transport security and the procedures surrounding them. These security procedures are discussed in the following sections:

- Threat to passenger security;
- Threat response;
- Policies and regulations governing the security of passengers;
- Passenger safety responsibility;
- Air carrier responsibilities; and
- Security process flow at airports.

2.2 The Threat

In the researched literature (see Appendix A – Bibliography) threats were identified both as ongoing operational issues and as short-term countermeasures, intended to deal with higher national or international threat situations. Security activities as identified in the reviewed material focused on many areas including the following:

- The security of civil aviation;
- Cargo/mail;
- Aircraft supplies & fuel;
- The aircrew and related baggage;
- Checked baggage (both originating and in-transit);
- Carry-on baggage; and
- The passenger (both originating and transit).

This report focuses on the baggage and passenger categories although consideration will be given to the actions and solutions devised for the remaining areas.

There are two basic threats to passengers – called Acts of Unlawful Interference –

(1) Taking control of the aircraft and passengers using items, such as weapons or explosives, within the passenger cabin; and
(2) Explosives placed in the aircraft cargo hold by terrorists.

2.3 Threat Response

Currently, authorities respond to increases in threat levels through procedural responses. For example, in Canada, the passenger screening gates always operate at a state of "Basic Readiness" (i.e., when there is no known, specific threat). The level of inspection increases with the level of threat, with a corresponding decrease in throughput (although it is not a linear correlation). However, there is no impact on equipment in terms of capability or functionality, only an increase in utilization.

- **Basic Readiness**:
  "This condition reflects the possibility that an attack against Canadian aviation interests or foreign aviation interests under Canada's protection could occur as evidenced over time by events in Canada and on the international scene. No additional information concerning a specific attack would be available."

- **Alert Condition 1** – Increased Vigilance
  "Alert Condition 1 would be declared when it is ***believed*** that an attack against Canadian aviation interests or foreign aviation interests under Canada's protection ***may*** be planned or underway, although likely targets and timing could not be ascertained. "

- **Alert Condition 2** – Precautionary Measures
  "Alert Condition 2 would be declared where an attack against Canadian aviation interests or foreign aviation interests under Canada's protection was considered ***probable*** but the specific target and timing has not been ascertained. Information giving rise to the declaration would be sufficiently credible to justify the implementation of enhanced alert security measures to restrict access to and increase surveillance of potential targets. "

- **Alert Condition 3** – Maximum Measures
  "Alert Condition 3 would be declared where an attack against Canadian aviation interests or foreign aviation interests under Canada's protection is considered ***imminent*** and information is sufficiently credible to justify the full implementation of security measures. This condition could also be declared when an attack was underway. "

Each set of security measures builds on the measures previously put in place. This means that all of the security measures in place at the "Basic Readiness" state are still in place when an Alert Level 1 is called, but some additional measures may also be put in place.

For example:

- Under Basic Readiness, all carry-on baggage is screened using X-rays and, in addition, 15 percent of all baggage is hand-searched on a random basis.
- Under Alert Level 1, 25 percent of the baggage is hand-searched and 100 percent is screened using X-rays.
- Under Alert Level 2, 50 percent of the baggage is hand-searched and 100 percent is screened using X-rays.
- Under Alert Level 3, 100 percent of the baggage is hand-searched and 100 percent is screened using X-rays.

Similar increases in other security measures also take place to make it more difficult for the target to be reached.

It should be noted that, although the amount of equipment used does not increase, the procedures applied at the security gates, and the number of people involved, increase as the threat escalates. The use of X-rays also increases to include the screening of checked baggage under certain alert conditions. It would clearly be impractical to bring in additional equipment to counter a threat situation expected to last a few days at most.

2.4 Policies and Regulations Governing the Security of Passengers

2.4.1 Background

Documentation from the airline security industry and political discussions shows that the completeness and rigor of the screening process has been evolving. As political pressure or the perceived level of threat has increased, the level of screening for checked and carry-on baggage has also increased. The obvious goal, in the near or long-term, depending on the country, is 100 percent screening.

Performance figures such as Probability of Detection (PD) and Probability of False Alarm (PFA) are slowly being introduced into the literature as the technologies improve, but no international agreement on the definition of these terms or on the related figures exists. The current goals are limited by the available technology, the acceptability of delays, and the costs involved.

2.4.2 Security Requirements

The International Civil Aviation Organization (ICAO) is an international agency under the umbrella of the United Nations. In 1944, ICAO was established to regulate the anticipated increase in aviation travel and shipment of goods. The Chicago Convention of 1944 was the legal instrument used to establish the organization. Canada, as a member state, signed the convention and thereby became a member of ICAO. Based in Montreal, ICAO regulates all aspects of civil aviation. One of the areas it regulates is aviation security.

Since then, several conventions relating to aviation security have been held:

- The Chicago Convention (1944);
- The Tokyo Convention (1963);
- The Hague Convention (1970);
- The Montreal Convention (1971);
- The Protocol to the Montreal Convention (1988); and
- The Marking of Explosives Convention – Montreal (1991).

Annex 17 to the Convention on International Civil Aviation relates specifically to security.

It sets out, in very general terms:

- What ***must*** be done by member states (Standards); and
- What ***should*** be done (Recommended Practices).

ICAO security measures in Annex 17, Recommendation 4.3.2 state that "member states are required to prevent explosives or any dangerous devices which may be used to commit an act of unlawful interference, the carriage of which is not authorized, on board an aircraft engaged in international civil aviation".

The flowchart shown in Figure 1 shows the cascading effect of the Conventions on the Canadian legal system and the laws generated in response to the Conventions, Annex 17, and the ICAO Security Manual. Other countries or "member states" have similar legislation.

In the literature, emergency plans exist to deal with non-normal situations. Such plans involve the imposition of more complete searches and more restrictive procedures for personnel and for baggage handling. The levels of physical screening increase as the threat level increases. Certain automated means are doubled-up (i.e., a second pass through metal detection equipment is instituted) to increase the probability of detection.

In Canada, certain parts of the Conventions dealing with criminal acts, such as sabotage, hijacking, and carriage of weapons or explosives on board an aircraft or into terminal buildings, were incorporated into the Canadian Criminal Code.

The Aeronautics Act incorporated the provisions of Annex 17 in a very general sense. The Act places the responsibility for security on airport and airline operators.

Two sets of regulations were promulgated pursuant to the Act:

- The Air Carrier Security Regulations; and
- The Aerodrome Security Regulations.

The very detailed security features are not publicly known but are contained in the Aerodrome Security Measures and the Air Carrier Security Measures.

In light of the ICAO Annex 17 security measures requirements, ICAO has recommended that, by the end of 2000, member states achieve a goal of 100 percent baggage screening against suspicious and dangerous material that may be misused onboard aircraft. In 1999, this deadline for implementation has been extended once again.

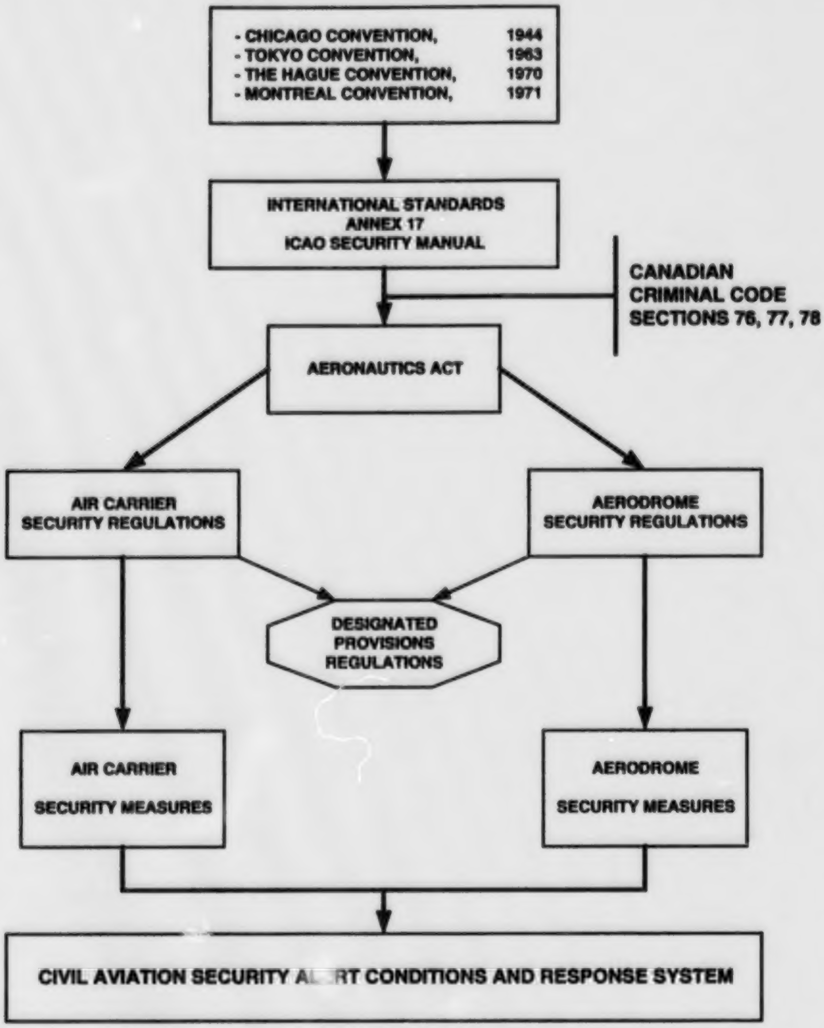

- CHICAGO CONVENTION, 1944
- TOKYO CONVENTION, 1963
- THE HAGUE CONVENTION, 1970
- MONTREAL CONVENTION, 1971
INTERNATIONAL STANDARDS
ANNEX 17
ICAO SECURITY MANUAL
CANADIAN CRIMINAL CODE SECTIONS 76, 77, 78
AERONAUTICS ACT
AIR CARRIER SECURITY REGULATIONS
AERODROME SECURITY REGULATIONS
DESIGNATED PROVISIONS REGULATIONS
AIR CARRIER SECURITY MEASURES
AERODROME SECURITY MEASURES
CIVIL AVIATION SECURITY ALERT CONDITIONS AND RESPONSE SYSTEM

Figure 1 ICAO Standards and Regulations as Applied in Canada

In this report, the aspects associated with the right-hand side of the regulations, procedures, and acts as listed in Figure 1 are not discussed. The Canadian Criminal Code sections 76, 77, and 78 are not pertinent to this study. Aerodrome Security Regulations enacted by the Canadian government along with the Designated Provisions Regulations and the Aerodrome Security Measures Acts (enacted in Canadian law) are not applicable to the operation and integration of data from security equipment used in airports to implement these various regulatory requirements.

ICAO has taken the implementation of Annex 17 further by publishing a Security Manual that amplifies the information it contains. In addition, Appendices to the Security Manual go into even greater detail on certain specific security subjects.

The recommendations drafted by ICAO address the implementation of 100 percent checked baggage scanning. This requirement was drawn up after Pan Am flight 103 was destroyed over Lockerbie, Scotland.

For ICAO recommendations to take effect, they are to be implemented in law, in each country that is a signatory to the conventions.

The civil aviation security program is structured around the detection, deterrence, or mitigation of the terrorist threat by preventing explosives and personal weapons from being carried onboard aircraft. In Canada, Transport Canada's aviation security authorities have been supporting the development of technologies at the implementation level.

Currently, very little data is shared by the various airport or airline security systems. In addition, Europe, Canada, and the USA have differing approaches to:

- Regulations addressing air travel security;
- Approaches to air travel security; and
- Ways of implementing the regulations and procedures.

The security approach used in Canada and the USA is to intercept baggage and other packages that may contain restricted materials. The policy is to detect this material, with a very high degree of probability and with a minimum rate of false alarms at each interface, and be able to prevent its entry onboard an aircraft. The success of this process depends on the detection of these materials at an inspection portal or barrier. In this mode of operation, the security systems do not know who or what organization has had access to the baggage that is being inspected. In this situation, the weakest link becomes the limiting level to which protection can be maintained.

In this approach, no linking or fusion of data from multiple sources occurs. Each interface operates independently from all others:

- Check-in counter.
- Carry-on baggage scanner:
  - X-ray.
- Passenger screening:
  - Metal detectors.
- Checked baggage scanner:
  - X-ray;
  - Ion beam scanner;
  - Trace Vapour detector;
  - Trace Particle detector.
- Boarding gates:
  - Passenger and baggage reconciliation.

2.5 Passenger Safety Responsibility

2.5.1 Air Carriers

By regulation, in both Canada and the USA, the air carriers (airlines) are responsible for the security and safety of passengers. As a result, the air carriers are responsible for implementing a system that meets passenger screening security requirements.

Generally, air carriers are very sensitive to processes imposed by regulators and the related costs of implementation. Any system implemented has to be inexpensive, significantly better at detecting threats, and able to leverage existing investments in infrastructure.

Another barrier to implementation is resolving the security versus throughput problem. In the past, additional security has meant reduced passenger throughput, which annoys the air carriers and the public alike.

2.5.2 Airport Authorities

Airport authorities, such as police, customs, immigration, and regulators, are responsible for different aspects of airport security, but not for passenger safety directly. However, any system designed to integrate data should consider these "external" agencies.

2.6 Security Process Flow at Airports

The airport security process flow is shown in Figure 2. The "system" is generally based on isolated checkpoints whose cumulative probability of negating a threat is very high. The system is very procedure and labour intensive and does not offer a particularly robust method of correlating data from various sensors.

For example, screening quality control currently emphasizes the use of physical searches for greater accuracy. At the same time, the difficulty of motivating security personnel and maintaining adequate levels of concentration is acknowledged. To counter this problem, security personnel are normally switched every 15 to 20 minutes to maintain their alertness levels.

Such challenges suggest that automated means, or at least automated assists and alarms, are mandatory to improve the quality of the screening process. As the traffic volume increases in the future, the security process at airports will require the increased use of technology if it is not to adversely affect throughput. Figure 2 also shows what data might potentially be available at each security checkpoint.

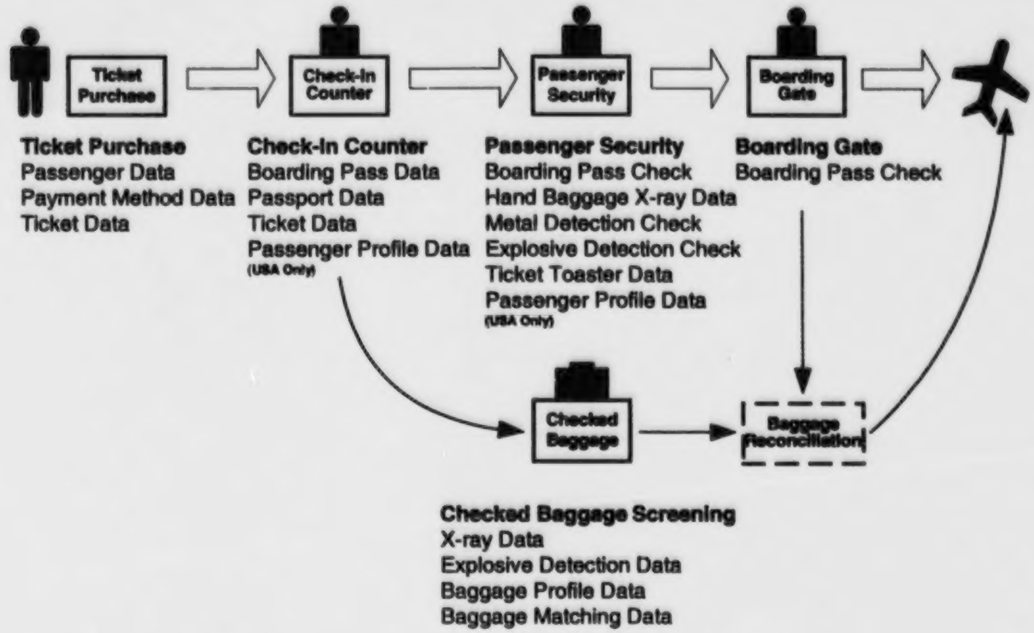


Figure 2 Airport Security Process Flow

At the present time, Canadian airports cannot match information collected by the airlines during ticket issuance (such as home and business address, employer, and credit information) with other sensor information and process data at the airport.

Without positive identification of the passenger, it is possible that the person whose name is on the ticket is different from the person checking in at the airport, who may be different from the person going through security, who may be different from the person boarding the aircraft. *There is no guarantee that criminal or terrorist elements will not give tickets or boarding passes to an accomplice.* Video imaging techniques and video data compression hardware technology would allow passenger identification and verification at critical checkpoints in the airport. Tagging other information and sensor data with an actual video picture of the passenger would also be very effective. This systems approach would provide a verifiable audit trail when integrating or fusing information collected at different locations, from different sources, at different times, from around the airport facility.

2.6.1 Ticket Purchase

2.6.1.1 Introduction

The process for purchasing a ticket for travel on airlines is constantly changing and is being automated. At one time tickets had to be purchased at either a travel agent or the airline counter, but today the ticket can be obtained in many different ways:

- travel agency;
- airline sales office;
- airline ticket counter;

- internet sources;
- telephone sales organizations; and
- automated ticket dispensers at airport.

With the ability to purchase tickets by these various means, an equal number of ways to pay for these tickets have developed. Not only are the ways and means of purchasing and paying for tickets becoming varied, but the documentation for these tickets is also changing. At one time only the official style ticket would be accepted as proof of purchase and the guarantee of a seat on the flight. Today this documentation is provided in many different ways. Today, the ticket purchaser may never have met any person directly, face-to-face, to obtain their ticket. Different types of ticket documentation are:

- standard airline ticket;
- swipeable airline tickets;
- e-tickets (electronic air pass);
- kiosk check-in – boarding pass only;
- fax confirmation letter;
- reservation number only;
- smart cards; and
- travel pass cards.

Ticket data is now generally confirmed by external documentation such as a fax copy of the flight and ticket information with a reservation number to identify the ticket holder. In some of the new electronic ticket machines (kiosk check-in) being installed at airports, the passenger can purchase and pay for the ticket without ever seeing a check-in counter.

This approach is gaining favour, as many of today's travellers do not carry much baggage with them and there is no checked baggage to be concerned about. In this mode of travel, the passenger could purchase a ticket, pay for it, and receive his boarding pass without being checked in by the airline. At the boarding gate these passengers have their tickets validated and board the flight.

These electronic modes of ticket purchase leave the check-in counters for other passengers. The electronically ticketed passenger may not even have a boarding pass to show as he or she passes through the passenger security screening barrier.

The baggage check-in function may be automated for frequent fliers who have smart cards or other airline-provided identification cards issued to them. These various methods of speeding passenger throughput and convenience are being tried today around the world. This technology is being implemented to give frequent fliers more convenience, foster customer brand loyalty, and possibly lower travelling costs.

2.6.1.2 Air Canada E-Ticket Process

The following procedures and comments have been extracted from the Air Canada Web site: "http://www.aircanada.ca/services/business/if104a.html#Eticketing".

2.6.1.2.1 Electronic Ticketing Services

Air Canada is doing away with paper tickets; instead, they are introducing the E-Ticket. Otherwise known as Electronic Ticketing, the E-ticket makes air travel easier to select Air Canada destinations in North America, in Glasgow, Manchester and London, UK, Frankfurt, Hong Kong, Bermuda, and in East & West Caribbean.

E-Ticket is a service that creates an electronic ticket with all the information formerly printed on a paper ticket and stores it in a computer database. Once the reservation has been made through a preferred travel agent or Air Canada and paid for, there is no paper ticket to worry about. A copy of the E-Ticket itinerary/receipt is made available by mail or fax.

Boarding passes are issued on the day of travel at any Air Canada airport ticket counter, check-in counter or at the departure gate. Passengers check in simply by showing the credit card used to purchase the E-Ticket or a photo identification (ID) document.

2.6.1.2.2 Booking The Flight

Purchase of the ticket is facilitated by using a credit card or another form of payment, and an assigned seat is reserved. There is no need to have a paper ticket issued or delivered. Changes to travel plans or cancellations can be made with a simple phone call to the preferred travel agency or Air Canada.

Passengers with baggage show a photo ID or the credit card used to purchase the ticket at any Air Canada check-in counter, and receive their boarding pass. The name on the ID has to match the name on the itinerary/receipt. Passengers without baggage proceed directly to the gate to get their boarding pass and simply show their E-ticket itinerary/receipt at airport security. However, at Canadian airports with pre-clearance facilities, passengers travelling to the United States need to obtain their boarding passes at the check-in counter.

Passengers travelling between Canada and the United States may be required to present their E-ticket itinerary/receipt to customs and immigration officers.

2.6.1.3 Canadian Approach

In Canada, many of the various ticketing approaches are being implemented. Except for the smart card technology and the fully automated passenger departure functions, all the rest have been implemented or are starting to be installed at major airports.

As described in Section 2.6.1.2, the Canadian airline industry is quickly following the rest of the world in automating ticket sales and boarding procedures.

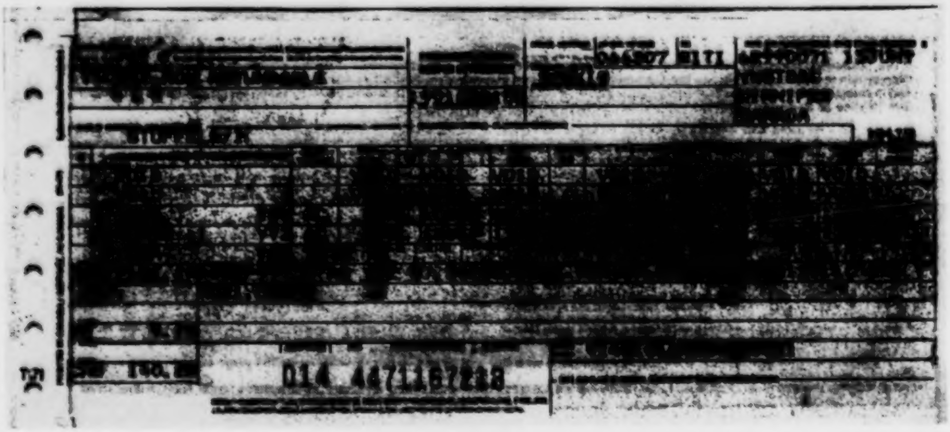
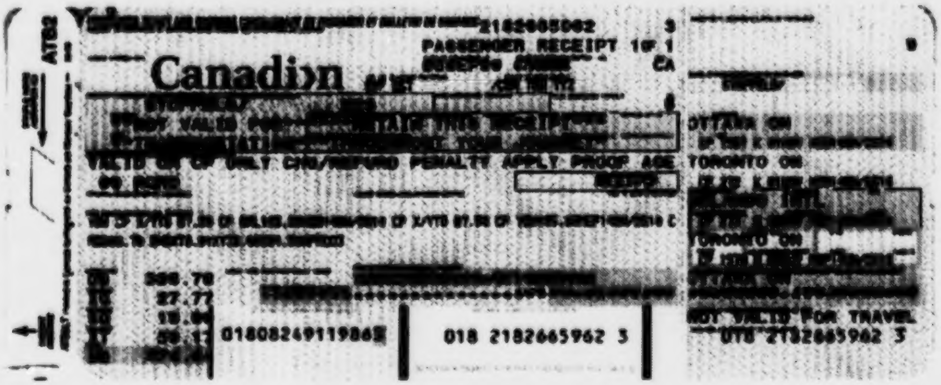


Figure 3 Sample of Standard Issue Airline Ticket Receipt



PASSENGER RECEIPT 1 OF 1

Canadi>n

OTTAWA ON

TORONTO ON

0180824911986

018 2182665962 3

NOT VALID FOR TRAVEL

Figure 4 Sample of Standard Issue Electronic Ticket Receipt

The electronic ticket shown in Figure 4 has a magnetic stripe on the back for additional data that can be read electronically by a swipe-through card reader.

2.6.1.4 US Approach

In the USA all of the functions described in the introduction section except for the automated checked baggage and passenger departure functions are being implemented.

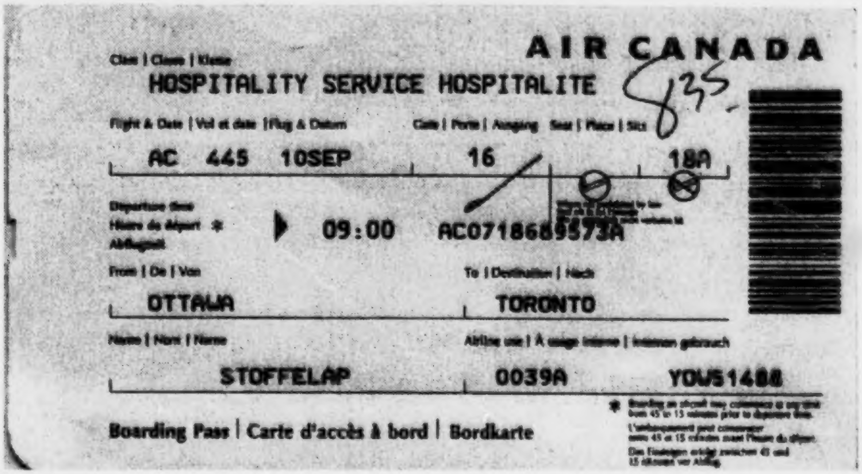
Alaska Airlines and its regional subsidiary, Horizon Air, are committed to a full combination of E-tickets and kiosk check-in, while searching for the best means to ease customer identification. They are testing smart cards for that purpose.

Alaska now sells more than 50 percent of its tickets electronically. E-ticket holders can go to a kiosk, enter their ticket, credit card or mileage plan number, and obtain their boarding passes.

2.6.2 Check-In Counter

2.6.2.1 Introduction

The ticket counter/check-in counter is generally the first point of contact of the passenger with the airport security system. Here the airline databases and customer profile data are available to determine the potential security risk the customer presents to the airline and the travelling public. Here the history data and the change data for the particular ticket presented for travel can be determined.



AIR CANADA

Class | Classe | Klasse
HOSPITALITY SERVICE HOSPITALITE

$35

Flight & Date | Vol et date | Flug & Datum — AC 445 10SEP
Gate | Porte | Ausgang — 16
Seat | Place | Sitz — 18A

Departure time
Heure de départ *
Abflugzeit — 09:00

AC0718689573A

From | De | Von — OTTAWA
To | Destination | Nach — TORONTO

Name | Nom | Name — STOFFELAP
Airline use | À usage interne | Internen gebrauch — 0039A YOWS1488

Boarding Pass | Carte d'accès à bord | Bordkarte

Figure 5 Sample Boarding Pass

At the check-in counter, the ticket data is confirmed, a boarding pass is printed, and checked baggage tags are printed and attached to the baggage presented here for routing to the proper flight and then on to the destination.

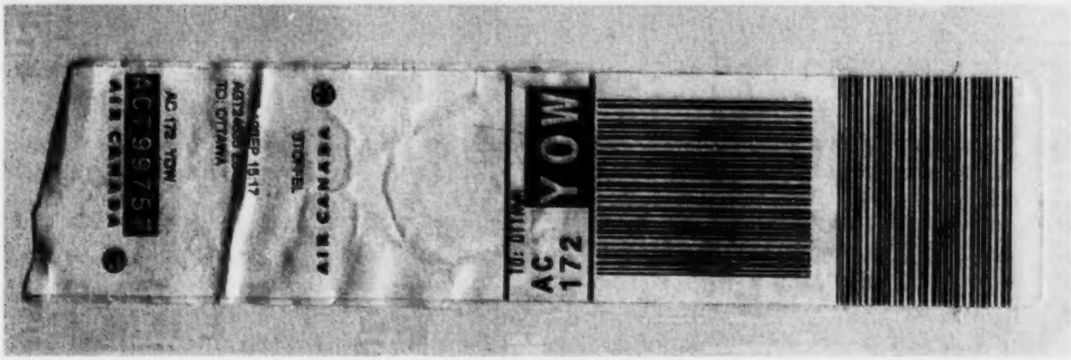


Figure 6 Sample Checked Baggage Tag

Once the checked baggage has been tagged and identified, the baggage claim portion of the tag is inserted into the ticket folder or ticket receipt.

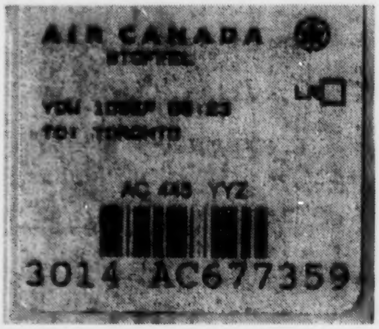


Figure 7 Sample Checked Baggage Claim

The practice (in Canada) has been to use manual profiling to determine whether a traveller presents a risk element. Such a determination can be most readily made at this point. Once the passenger has been released to proceed to the aircraft boarding gate, this security option for more extensive investigation has passed.

Passenger profiling, either manual or computer-assisted, will (has) become an important part of the US approach to maintaining the air traffic system passenger flow while meeting security requirements.

2.6.2.2 Canadian Approach

In Canada no requirement exists for security screening or passenger profiling at the check-in counter to ascertain a traveller's risk level. In situations where the behaviour of the passenger is suspect (out of the norm), the check-in personnel can inform airport security about their concern and the airline security personnel will make the final decision on whether enhanced security measures should be taken with this person and his/her baggage.

The criteria for evaluating the passenger for profiling are based on several scientifically determined parameters and can be implemented in an automated way for most situations (if needed). A more detailed description of these parameters and methods is described in Section 2.6.2.3.

2.6.2.3 US Approach

The US Federal Aviation Administration (FAA) require implementation of automated passenger profiling to exclude the great majority of passengers from additional security procedures. This requirement is/was initially recommended for passengers flying overseas. The FAA Commission has recommended that bag matching be implemented[1]. This requirement was linked to another recommendation that it be initially based on profiling of passengers going overseas, flying out of airports located in the United States. As with manual profiling, the purpose of automated profiling is to exclude from the additional security measures the great majority of passengers, who are very unlikely to present any threat and, conversely, to identify passengers to whom heightened security measures should be applied. Unlike manual profiling, however, automated profiling offers numerous advantages, including elimination of the potential perception of personal biases, greater sophistication, speed, accuracy, flexibility, and protection against compromise of sensitive security information. The FAA Commission discussed a Computer Aided Passenger Screening System (CAPS) developed by the FAA and Northwest Airlines and recommended that the FAA implement an automated profiling system by

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[1] Department of Transportation and Federal Aviation Administration 14 CFR Part 108, Security of Checked Baggage on Flights Within the United States; Proposed Rule. [Docket No. FAA–1999–5536; Notice No. 99–05] RIN 2120–AG51 from Federal Aviation Administration (FAA), DOT. with Notice of Proposed Rulemaking (NPRM).

December 31, 1997. On January 1, 1998, several air carriers voluntarily implemented CAPS, and most other carriers have since opted to implement it as well. The few carriers that have yet to complete the phase-in of CAPS are in the process of system-wide implementation.

The White House Commission on Aviation Safety and Security, known as the Gore Commission, was established in July 1996 and issued its initial report, which included 20 recommendations to enhance aviation security[2] in September 1996. Some of the recommendations regarding passenger screening or profiling CAPS system are referred to in this section.

Airlines began to develop the CAPS system. This automated screening system was designed to separate out that small percentage of passengers who should be subject to additional security measures. These measures could include subjecting their checked bags to screening by more sophisticated explosives detection equipment or ensuring that they actually board the same aircraft as their baggage (i.e. bag matching).

The factors the airlines use are a secret, but airlines insist race, religion, and national origin are not factors[3]. Published reports indicate that the factors include frequency of travel to certain destinations, whether the passenger is a member of the airline's frequent flyer program, and whether the ticket was bought with cash or a credit card. The latter two are factors because it is assumed that terrorists would not participate in a program or use methods of payment that would reveal aspects of their identity.

Opponents of profiling fear that passengers who fit the profile could face intrusive questioning and public embarrassment, such as having their baggage searched in front of other passengers. However, proponents of profiling insist that passengers might never know they have been selected. For example, passengers might not know that the airline is running their checked baggage through a sophisticated explosives detection device or double checking that they actually boarded the flight.

Due to the concerns raised about the potential for discrimination, DOT and the Gore Commission asked the Justice Department to review the CAPS profiling system. The Justice Department issued its report on October 1, 1997. It made the following findings:

- CAPS does not include race, religion, or national origin as a screening factor;
- Neither the Constitution nor any Federal law prohibits the implementation of the CAPS system;
- To a limited degree, CAPS distinguishes between passengers on the basis of whether or not they are American citizens but that this is justified and constitutional; and
- FAA should require airlines to establish procedures for implementing CAPS to ensure that it is not done in a discriminatory or insensitive manner.

Guidelines for security of checked baggage and passengers for flights within the United States have recently been published[4] by the US Department of Transportation, Federal Aviation Administration.

2.6.2.3.1 Manual Profiling Criteria

It is known that routine checks of checked and carry-on baggage by X-ray can rarely discover 100 percent of the sophisticated explosive devices used by terrorist organizations in recent years. In information presented at seminars by Renful Aviation Security Ltd. from England, criteria and key indicators are presented that are used in a manual Passenger Profile Screening Process. This screening process has been developed to increase proficiency of airline personnel in identifying certain categories of people who may attempt to board a flight, but must be prevented from doing so.

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[2] **Final Report by Vice President Al Gore**, Chairman of the White House Commission on Aviation Safety and Security. President Clinton established this Commission by issuing Executive Order 13015 on August 22, 1996 with a charter to study matters involving aviation safety and security, including air traffic control, and to develop a strategy to improve aviation safety and security, both domestically and internationally. Report was issued February 12, 1997.

[3] Committee on Transportation and Infrastructure; Subcommittee on Aviation; Hearing May 14, 1998 Status of Aviation Security efforts with a focus on the National Safe Skies Alliance and Passenger Profiling Criteria.

[4] Guideline are published in "The US Department of Transportation; Federal Aviation Administration; 14 CFR Part 108, "**Security of Checked Baggage on Flights Within the United States; Proposed Rules."** Document is labeled "faa_profile_regs.pdf" on the FAA Web site.

An appropriately trained profiler will make specific observations, combined with methodical analysis of all the information obtained from a passenger's:

- appearance and behaviour;
- air ticket and location;
- passport and documentation;
- travelling companions; and
- baggage.

The profiler should expertly question the passenger to confirm or resolve any doubts or suspicions that are identified, whilst carefully analyzing the answers, disposition and body language. This process allows an informed decision to be made regarding the passenger's validity and status and enables the profiler to identify any undesirable or potentially dangerous passengers.

An appropriately trained profiler will rapidly identify bona fide passengers and process them with a minimum of inconvenience or delay.

2.6.2.4 Other Considerations

2.6.2.4.1 Airline Reservation System Access

Airlines are very sensitive about their reservation databases and access to any other information about their routes. Any security system should take these sensitivities into account.

2.6.2.4.2 Video Imaging

Video imaging at the check-in counter is the only way that the behaviour and identity of a passenger can be confirmed. Without digital video imaging and recording of the person checking in, the identification of this person is largely determined by post-event airline personnel reports.

Combining the digital video recording of the passenger check-in process at the check-in counter with the data received from the airline reservation system, the airport security system database can create a record that can be used to link other pertinent data from security checkpoints around the airport.

In most situations, the video recording (without audio) of the check-in process should be permissible, as it is already being performed on a random basis; there are security cameras all through airport facilities now. This check-in recording can be used to verify the CAPS functions (if implemented) to determine the validity of the criteria used to determine passenger probability of risk.

The digital recording and storage of the check-in process by passengers can be implemented using technology already available and this function would fit into the existing check-in procedures without having to alter any of these processes. Spin-off benefits from implementing this technology could include recording of rude or unreasonable passenger behaviour, which could be used to redress such situations. All such issues could fall into the airport security system functions and indicate potential future passenger behaviour.

This function could fit into existing airline reservation computer database functions and, with the right airline partner to set up such a system, it should be totally integrated without excessive costs.

With video cameras at every ticket and check-in counter at an airport, it would also be possible to implement computer-based passenger identification at downstream checkpoints.

2.6.2.4.3 Video-Based Passenger Identification

Passenger identification is an area of leading edge technology that is just now becoming feasible and implementable. This technology uses devices such as CCTV video cameras or high resolution electronic imaging cameras to provide input to the computer-based identification system. Such a system could be an option if the CCTV video functions are implemented at check-in counters.

The digital video already acquired and stored in the airport security system database, could be used in future enhancement of the installed system. Once the video acquisition and recording functions are installed, these additional features could be added without revamping the systems already in place.

This is non-intrusive technology and would not appear to be an invasion of individual rights. The recorded video database could be used in post-event investigations into individuals involved in criminal behaviour or in incidents involving air travellers or aircraft. All of the individuals involved in an incident could be identified and pictures of them retrieved into a historical database for future access.

2.6.3 Passenger Security Checkpoint

2.6.3.1 Introduction

At all North American airports, for all commercial flights, passengers and carry-on baggage are inspected for prohibited items. Passenger screening is one approach used to prevent the carrying onboard aircraft of restricted items such as knives or guns. This screening process is implemented by manual inspection, X-ray scanning of all carry-on baggage, and use of magnetic anomaly detection equipment to detect metallic components and materials carried by passengers on their person.

At small airports and for small aircraft with fewer than 61 seats, manual inspection of carry-on baggage is acceptable for implementing the required security measures. For larger airports and larger aircraft, manual inspection is time consuming and leads to excessive boarding delays. To meet the passenger security requirements at airports with high volume passenger traffic, several approaches have been developed, but the most common is to X-ray scan all carry-on baggage and manually inspect a small percentage of the baggage.

Existing commercial X-ray scanners give high resolution images of the interior of objects. They have been used for many years to check hand-carried baggage and, more recently, checked baggage.

If the X-ray scanning equipment displays prohibited or questionable items in the bag under observation, the operator can decide that the carry-on bag contents should be checked further. If further inspection is required, the suspect baggage is opened and a manual, physical inspection is made of the contents. At this second point, the inspecting security guard makes the final decision regarding whether the tagged item is acceptable or not. Before submitting to physical inspection, the passenger can choose to allow the process to continue or leave the gate and miss the flight.

After screening, passengers are kept physically isolated from non-screened people until boarding is complete. A boarding pass (in Canada) is also required as "authorization", permitting the passenger onto the flight. It is assumed that transit passengers have been screened upstream so they are not normally re-screened unless they leave the secure area. Procedures regarding the use of boarding passes and screening steps, however, vary widely from country to country.

The ICAO guidelines require 100 percent passenger screening but do not specify the accuracy of the screening. In addition, the guidelines express concern that such screening does not impede the flow of passengers. It is assumed that effective, 100 percent screening of passengers and carry-on baggage cannot be fulfilled through metal detection, X-ray, trace, or any other technology alone because of the requirement to detect both explosives and weapons.

It is also assumed that the screening of passengers and carry-on baggage will include physical searches, either on a random percentage of the total traffic or in response to a detection alarm from whatever technology is employed.

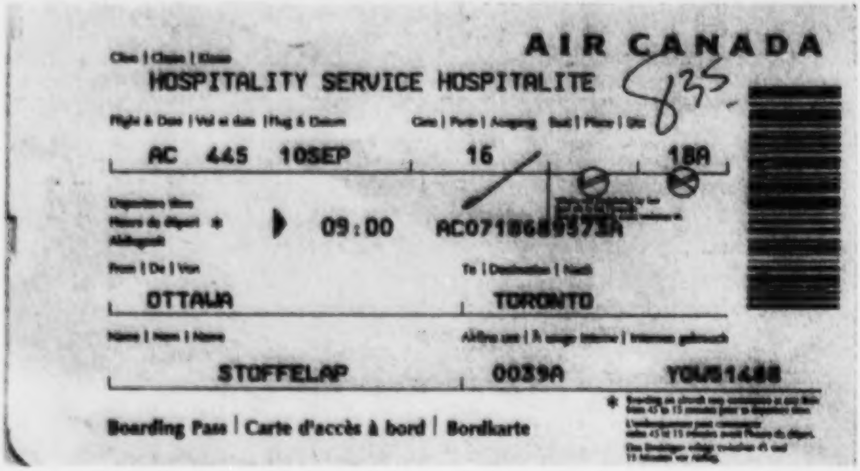

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Figure 8 Sample Airline Boarding Pass

2.6.3.2 Canadian Approach

The Canadian approach is to restrict aircraft boarding areas to passengers only at all times.

2.6.3.2.1 Passenger Screening

In Canadian airports, the boarding areas of the airports are restricted spaces and only passengers with boarding passes or tickets are permitted access through the passenger security checkpoint.

These passengers undergo an inspection of their carry-on baggage as well as a personal scan for metallic objects. The carry-on baggage is X-ray scanned by a carry-on baggage scanner and the passengers all walk through a metal detector for a personal check for prohibited devices (i.e., metallic items such as guns).

2.6.3.2.2 Carry-On Baggage Screening

In Canada as in the US, all carry-on baggage entering the passenger compartment of an airliner must be screened. The carry-on baggage that accompanies passengers is X-ray scanned by a checked baggage scanner. This system takes an X-ray image of the contents of the bags and a system operator determines whether or not the contents are acceptable for entry into the aircraft compartment.

If the operator decides that the bag should be checked further, the suspect baggage is opened and a manual, physical inspection is made of the contents. At this second point, the inspecting security guard makes the final decision regarding whether the tagged item is acceptable or not. In Canada, passengers do not have the right to refuse physical inspection of their persons or carry-on baggage. Once a passenger attempts to enter the passenger secured area, he or she has relinquished the option to leave the check-in process. While the carry-on bags are scanned for prohibited items, the passenger walks through a metal detector for a personal check for prohibited devices (metallic items).

2.6.3.3 US Approach

The US approach is to permit access to the aircraft boarding areas by the public. In times of heightened security, this public access may be restricted to passengers only.

2.6.3.3.1 Passenger Screening

In US airports, passengers and visitors all go through the passenger security checkpoint to the boarding gate area. No effort is made to restrict access to the boarding gates.

The carry-on baggage is X-ray scanned by a baggage scanner and all passengers walk through a metal detector for a personal check for prohibited devices (i.e., guns). No effort is made to restrict access to the aircraft boarding gates.

In enhanced or high security periods, access to these boarding areas is restricted to passengers with valid boarding passes and accompanying persons with the proper passes.

2.6.3.3.2 Carry-On Baggage Screening

In the US, all carry-on baggage entering the passenger compartment of an airliner must be screened. The carry-on baggage that accompanies passengers is X-ray scanned by a checked baggage scanner. This system takes an X-ray image of the contents of the bags and a system operator determines whether or not the contents are acceptable.

If the operator decides that the bag should be checked further, the suspect baggage is opened and a manual, physical inspection is made of the contents. For manually inspected bags, the inspecting security guard makes the final decision regarding whether the tagged item is acceptable or not. Before submitting to physical inspection, the passenger can choose to allow the process to continue or leave the gate and miss the flight.

2.6.4 Checked Baggage Security Checkpoint

2.6.4.1 Introduction

Currently, the screening of checked baggage is limited mostly to international flights, and its extent depends on the country of origin as well as the perceived level of threat. However, ICAO decisions and trends suggest that such screening will increase considerably over the next five to ten years. **Screening is the responsibility of each airline, with monitoring and quality checking performed by Transport Canada.**

Originating checked baggage is to be screened, either electronically or physically, prior to being placed on the aircraft. The bags are to be maintained in a secure area after being screened. All baggage, either originating or transiting, is then reconciled with the passenger boarding tags to ensure that the passenger corresponding to the checked bag has boarded before the bag is loaded on the aircraft. If a passenger does not present himself or herself for boarding, their bags are to be withheld from the flight.

Although checked baggage that is in transit should have been screened as originating baggage, it may also be screened by the airlines on transfer in some cases.

The guidelines and recommendations for the future do not specify the accuracy of such searches but they do emphasize training and the motivation of the personnel assisting in the detection of those who pose a threat (terrorist). They also identify:

- the percentage of bags screened electronically; and
- the percentage of bags screened physically.

The guidelines leave the location of screening activities to the discretion of the local authorities. There are various advantages and disadvantages related to throughput, risk management, and cost, depending on when screening is performed. Options involve screening at check-in, boarding, or some other point in between. Transit baggage introduces further options, involving the movement of baggage between aircraft.

For example, according to the following excerpts from the GAO report for the Congress of the US to Congressional committees and subcommittees,[5]

> *"Officials of three principal aviation industry associations that we contacted, The Air Transport Association (ATA), Airports Council International-North America (ACI-NA), and American Association of Airport Executives (AAAE)—generally agreed with the current division of airport security responsibilities. These officials stated that the continuity of screening would be broken if the air carriers were not the ultimate responsible party. For example, under current procedures, if a passenger is identified as a potential threat at the airport check-in or ticket counter, the air carrier will label the passenger's bag appropriately and that air carrier will take additional security measures for examining the passenger's bag, such as sending the bag through explosives detection equipment. Under any scenario where the carrier is not responsible for all screening operations, the air carrier would have to transfer the information about the potential security threat to another entity, such as the airport operator, and then that entity would further scrutinize the passenger's bag. This would disrupt the continuity of the baggage screening process and allow for a potential break in the chain of information."*

On an average day in the US, air carriers load 2.3 million pieces of passenger baggage, and approximately 6500 bags per day are "misdirected"[6]. If air carriers cannot ship baggage with a greater success rate than that, it is not realistic to expect them to screen and secure bags effectively.

In his article, Charles G. Slepian says that Airports in America were not built with security considerations as a high priority. JFK Airport in particular is a security nightmare. Access control at JFK means controlling some 40,000 workers, 90,000 passengers and 800 planes, each day, on over 300 acres of land.

Because of the immensity of the task of controlling access to the various areas of the airport (i.e., the terminals, parking lots, hangars, commissaries, maintenance facilities, storage facilities, fuel storage areas, vehicle garages, the kennel, the fire house, etc.), access control has been parcelled out by the landlord (the New York Port Authority) to its tenants (mainly the major air carriers).

Following the TWA 800 disaster, the FAA set the standard for the detection of explosive material in checked baggage to a level that would assure passengers that the baggage checked and put onboard aircraft holds would not contain explosive materials or prohibited devices.[7] This level of inspection cannot be easily reached with the current technology deployed at airports for BEDS checking.

The FAA has mandated the development and deployment of Advanced Technology, at category 3 airports, that must perform to the specified level of detection probability. This type of technology, however, cannot handle very large volumes of baggage at any one time. To limit system overload and baggage delays, the airlines perform passenger profiling to determine which baggage needs to be checked. This checked baggage is then assigned the standard optical and letter tags used to route baggage to its destination but, additional indicators are printed on this high priority-type baggage to single it out for extra checking. This data can be read-out by the optical scanners used for baggage routing and sorting systems.

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[5] Document "FAA's Actions to Study Responsibilities and Funding for Airport Security and to Certify Screening Companies". GAO/RCED-99-53 Aviation Security.

[6] Article on Airport Security, Security at Domestic Aviation Facilities, 1996, by Charles G. Slepian, foreseeable Risk Analysis Center; at Web site http://www.frac.com/airline.htm.

[7] Visit report on conversations with Mr. Michael Thompson of Vivid Technology, Inc. on 21 June, 1999.

This program, called Computer Aided Passenger Screening System (CAPS), indicates which baggage is to be routed through the more sensitive and accurate baggage scanners. Using this approach, not all baggage is scanned, but suspect bags are scanned before they are loaded onboard aircraft.

2.6.4.2 Canadian Approach

ICAO requirements have been adopted in Canada to meet the minimum-security requirements applicable to international and domestic flights by translating these into Canadian law.

At the Ottawa International Airport (i.e., the Macdonald Cartier International Airport (MCIA)), and generally at all other Canadian airports, checked baggage is handled manually. Checked baggage is transported, by conveyor belt, to one of several baggage-staging areas in the building. There are at least four baggage-staging areas. They are used for:

- Air Canada
- Canadian Airlines (Hudson)
- First Air
- Pre-cleared US departures

At other airports, the methodology of baggage transport, and the distribution of baggage-staging areas, is probably similar. At this time, no known, automated, baggage-handling systems are used to scan, sort, and route checked baggage to its final aircraft staging area in Canadian airports.

2.6.4.2.1 Domestic Flights

For domestic flights, the checked baggage routing tag is read manually, and manually moved into the container assigned to the departing aircraft. The whole operation is done by hand.

No baggage checking is performed on any checked baggage unless the check-in counter operator performs some rudimentary passenger profiling and the passenger is behaving in a suspicious manner. In this event, the personnel at the desk may hold the baggage and have it checked by an X-ray machine used just for this purpose. Under all other conditions, the baggage is loaded directly on the aircraft, without any additional checking.

It is normal practice for a flight to depart with a passenger's bags checked onboard, whether or not the passenger has boarded.

2.6.4.2.2 International Flights

For international flights, there is a requirement to reconcile baggage with the passengers. For this reason, there is a different way of tracking the checked baggage. At check-in, each passenger or family group is assigned a security number, starting at "001". As each passenger checks in, the security number is incremented for each individual or family group. The security number, passenger name, departing airport name, destination airport name, airline, and flight number are all imprinted on the checked baggage tag. The number of bags/baggage tags are counted and the security number is reconciled with each set of bags.

At flight boarding time, the number of bags (baggage groups) that are loaded onto the aircraft are counted and their location in the aircraft hold is recorded. The baggage container number is recorded and the location of each container in the aircraft hold is also recorded. At the departure gate, the passengers check in, and as each passenger is boarded, their security number is cleared from the boarding list. In this way, baggage reconciliation is implemented by:

- Total checked bag count;
- Passenger check-in tracking; and
- Security number check-off.

Once all of the checklists are complete, and the checked-in passengers have been reconciled with the checked baggage count, the aircraft can depart.

In the event of a discrepancy between the bag checklist and the passenger list, it is assumed that the passenger is not on the aircraft. The checked baggage for that particular passenger must then be removed from the aircraft. This work can take an hour to an hour and a half. The speed of this process is enhanced when the baggage handlers have recorded the location of the bag by reference to a defined container or hold location. When this takes place, the whole aircraft does not need to be unloaded to remove the baggage.

2.6.4.3 US Approach

On continental US flights[8] (i.e., flights within the continental USA), 100 percent baggage screening has not been implemented, nor has the reconciliation of baggage with boarding passengers. This is partly because of the volume of traffic and time constraints, but also because of the lack of the certified, high-speed Bulk Explosives Detection Systems (BEDS) required to perform this function. As of the summer of 1999, only two prototype machines were certified for US airport BEDS applications:

- the L3 Communications machine (3DX 6000); and
- the InVision machine (the CTX 9000 DSi).

2.6.4.3.1 Domestic Flights

For inter-airline baggage checking, the same issues have limited the scanning of aircraft hold baggage (i.e., the large volume of baggage that moves through an airport, the short interval of time available between the arrival and departure of these flights, and the lack of technology). Slowing the flow of passengers to implement full baggage screening would result in unacceptable delays and increased air transport costs. For all of these reasons, the checking of hold baggage on US airlines has not been implemented on continental flights.

It is estimated that, at this time (circa 1999), no more than 10 percent of checked baggage on continental US flights is scanned for prohibited materials. The baggage that is scanned has been culled from the general flow because a passenger has been identified as a potential threat at the airport check-in or ticket counter. In this situation, the air carrier uniquely identifies the passenger's bag and takes additional security measures. For example, the passenger's bag may be sent through an X-ray scanner or explosives detection equipment. In most cases, gate personnel at the check-in or ticket counter determine whether further security checks are required, based on passenger profiling criteria.

2.6.4.3.2 International Flights

On international flights from Category 3 airports, all aircraft hold baggage is scanned for prohibited materials and the baggage is reconciled with the appropriate boarding list.

2.6.4.4 Other Considerations

The target of 100 percent screening encompasses both originating and transit baggage. To achieve the necessary transfer time, automated screening is employed to achieve "complete" screening.

It is not assumed that transit baggage has been screened elsewhere.

Given the distribution of domestic and international flights in North America, it may be reasonable to screen only international transit baggage for a few years. The end goal, however, is to screen all transferred baggage. In Europe (i.e., Heathrow Airport, UK), the proportion of domestic to international flights necessitated full screening of transit baggage by the end of 1996.

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[8] Document "Report to Congressional Requestors", February 1998, **Weaknesses in Inspections and Enforcement Limit FAA in Identifying and Responding to Risks**, GAO/RCED-98-6 FAA's Inspections and Enforcement.

It is assumed that the screening of transit baggage will include a physical search only after all automated means have been used to identify or confirm the presence of explosives.

The following are reasons for the use of technology:

- The technology may be capable of improving throughput and reducing delays in the system.
- Highly sensitive technology should be capable of detecting very well hidden explosives that a physical search might overlook.
- A physical search may be too time-consuming to be considered.

The resolution of detection of explosives (i.e., a "hit") requires reconciliation of the passenger with the bag(s).

The reconciliation may take place:

- in the transit area;
- in the baggage make-up area;
- in the restricted zone where the passenger is waiting; or
- in another special area.

This is followed by:

- intensive passenger profiling;
- the possibility of further technology-based screening; and
- a physical search of the bag and the passenger.

Of the options listed, the screening of the passenger baggage is generally performed in a special area or the baggage make up area. The passenger is present when his or her baggage is manually opened and inspected.

2.6.4.4.1 Aircrew and Related Baggage

Aircrew personnel are admitted into secure areas and onto the aircraft, after physical screening and/or authorization checks. Such checks vary, according to the country and the identified level of threat.

2.6.4.4.2 Aircraft Supplies

Aircraft provisioning supplies are screened physically, electronically, or procedurally by accepting such items only from authorized dealers. The personnel involved are pre-authorized to approach the aircraft and their access to the aircraft is limited.

2.6.4.4.3 Cargo and Mail

Cargo and mail are screened physically, electronically, or procedurally by accepting such items only from authorized dealers. The personnel involved are pre-authorized to approach the aircraft and their access to the aircraft is limited.

2.6.5 Boarding Gate

2.6.5.1 Introduction

In present-day situations (in Canada) the passenger tickets and/or boarding passes are collected and checked at the boarding gate as the passengers board the aircraft. This paperwork is collected by airline staff, checked for valid departure date, time, and flight, etc. This information is later entered into the computer reservation system to confirm that the ticket has been used and that the passenger has departed from the correct airport on a flight to his or her destination.

For international flights, the boarding passenger data is reconciled with the checked baggage loaded onboard the aircraft. In this process, a passenger count confirms that the number of passengers that have checked in are all aboard and that the checked bags for these passengers are also onboard. Should there be a discrepancy in this loading process, the errant baggage is unloaded from the aircraft, and in some cases the passengers are deplaned to check for their own baggage before it is reloaded onboard the aircraft.

At some airports in the USA, the passenger boarding data and the checked baggage are reconciled electronically and the process of boarding and checking is semi-automated. This process links the passenger boarding data with the boarding passes and the routing tags on the checked baggage. In this process, the airline has a good idea of where the baggage is located in the aircraft should it be necessary to unload for passengers who have been detained or who have not boarded the aircraft.

2.6.5.2 Canadian Approach

At Canadian airports, the boarding passes and (if ticketed) the travelling portion of the tickets are collected and checked at the boarding gate as the passengers board the aircraft. This paperwork is collected by airline staff as the passengers board the aircraft just before departure. These collected boarding passes and tickets are checked for valid departure date, time, and flight, etc. This information is later entered into the computer reservation system to confirm that the ticket has been used and that the passenger has departed from the correct airport on a flight to his or her destination.

2.6.5.2.1 Domestic Flights

In some airports the boarding passes are electronically scanned by a boarding pass reader as the passengers enter the aircraft. In such configurations, the boarding pass scanner can be interfaced to the ticket system and the state of aircraft boarding can be readily determined and can then also be used for baggage reconciliation purposes.

2.6.5.2.2 International Flights

For international flights the passengers boarding an aircraft will be checked against the passengers that have checked onto the flight. Canadian security requires the passengers checked in on the flight to be matched with the passengers boarding and with the number of checked bags loaded onto the aircraft.

2.6.5.3 US Approach

In the USA, the procedure for boarding an aircraft is similar in that the boarding passes and (if ticketed) the travelling portion of the tickets are collected and checked at the boarding gate as the passengers board the aircraft. This paperwork is collected by airline staff as the passengers board the aircraft just before departure. These collected boarding passes and tickets are checked for valid departure date, time, and flight, etc. This information is later entered into the computer reservation system to confirm that the ticket has been used and that the passenger has departed from the correct airport on a flight to his or her destination.

2.6.5.3.1 Domestic Flights

In some airports the boarding passes are electronically scanned by a boarding pass reader as the passengers enter the aircraft. In such configurations, the boarding pass scanner can be interfaced to the ticket system and the state of aircraft boarding can be readily determined and can also be used for baggage reconciliation.

2.6.5.3.2 International Flights

For international flights the passengers boarding an aircraft will be checked against the passenger list that has been compiled from the passengers checked-in on the flight. Security requires the number of passengers checked in on the flight to be matched with the number of passengers boarding and the number of checked bags loaded onto the aircraft.

If there is a discrepancy, a more intense check is made of the passenger list and the checked baggage list and the two must be reconciled before the flight can depart.

2.6.6 Positive Baggage Reconciliation

Positive baggage tracking and reconciliation systems are a requirement that was first implemented by Transport Canada. Now FAA rules also require airlines to implement baggage reconciliation systems. Positive baggage tracking enables airlines to comply with FAA aircraft security legislation.

Positive baggage reconciliation matches the travelling passengers with their onboard baggage. If a passenger fails to board the aircraft, the baggage for this passenger must be removed from the aircraft hold. On large aircraft, this process can take time. It can be costly for the airline and there can be ripple effects on other parts of their system.

2.6.6.1 Procedural Overview

When an airline has a positive baggage reconciliation system, passengers are subjected to normal check-in procedures and International Air Transport Association (IATA)-format bar-coded tags are attached to their baggage. Details of the passenger and the baggage – such as flight, name, number of pieces, tag numbers, etc. – are automatically transferred into the baggage database.

For transfer passengers, data is obtained from either:

- the point-of-origin (if they were through-checked); or
- from the transfer desk (where scanners may be used to read the re-claim portion of the tags).

In the baggage sorting area, the serial number of each container allocated to the flight is input into the database. As each bag is loaded into a container, its bar-coded tag is read with a scanning device. Database logging software instantly checks the tag number against the database to confirm that the bag is checked-in for that flight. If it is, the baggage handler receives a "green light" to load the bag.

At the departure gate, any passengers who have checked-in – but not boarded – are identified in the normal way. If the airline decides to depart without them, the baggage database is interrogated to determine the location of their baggage. This makes it possible – even on a wide-body aircraft – to find and remove the bags in just a few minutes.

2.6.6.2 Canadian Approach

For international flights departing from Canada, there is a requirement to reconcile the baggage with the passengers boarded. For this reason, there is a different way of tracking the checked baggage for international flights. At check-in, each passenger or family group is assigned a security number starting at "001". As each passenger checks in, the security number is incremented for each individual or family group. The security number, passenger name, departing airport name, destination airport name, airline, and flight number are all imprinted on the checked baggage tag. The number of bags (i.e., baggage tags) are counted and the security number is correlated with each set of bags.

At flight boarding time, the number of bags or baggage groups that are loaded onto the aircraft are counted and their location in the aircraft hold is recorded (i.e., the baggage container number is recorded and the location of the container in the aircraft hold is recorded). At the departure gate, the passengers check-in and, as each is boarded, their associated security number is cleared from the boarding list. In this way, baggage reconciliation is implemented by the use of:

- total checked bag count;
- passenger check-in tracking; and
- security number check-off.

Once all of the checklists are complete, and the checked-in passengers/checked baggage count is reconciled, the aircraft can depart.

In the event of a discrepancy between the bag check and the passenger list, it is assumed that the passenger is not on the aircraft. The checked baggage for that particular passenger must then be removed from the aircraft. This work can take about an hour to an hour and a half. The speed of this process can be enhanced if the baggage handlers record the location of each bag by reference to a defined container or hold location. In this way, the whole aircraft does not need to be unloaded to remove the errant baggage. Failure to remove such baggage can result in a large fine to the airline for failing to meet the Canadian air transport requirements.

2.6.6.2.1 High-Risk Airlines

For high-risk airlines such as El Al Airlines (Israeli National Carrier) or Air India, the security checking procedures are enhanced by the airlines' own requirements. These two examples are airlines that have been subject to terrorism or other threats of destruction. For these airlines, all baggage is screened using X-rays and, for El Al Airlines, all baggage is also hand-searched. In addition, these airlines fully implement baggage/passenger reconciliation to minimize the threat of hijacking or destruction of the aircraft or its occupants.

2.6.6.3 US Approach

For international flights departing the USA, there is a requirement to reconcile the baggage with the passengers boarded. At flight boarding time, the number of bags or baggage groups that are loaded onto the aircraft are counted and their location in the aircraft hold is recorded (i.e., the baggage container number is recorded and the location of the container in the aircraft hold is recorded). At the departure gate, the passengers check-in and, as each is logged, the baggage for these passengers is/can be loaded onto the aircraft.

Several systems in use at various airports can electronically log the boarding of passengers and give the green light to load their associated checked baggage onto the aircraft. In manual systems the approach is driven by the boarding pass and ticket collection and comparison to the check-in and checked baggage passenger list. In the event of a discrepancy between the two lists, a more stringent comparison is performed and if there is still a discrepancy, the baggage loaded for the missing passenger(s) is removed from the aircraft.

2.6.6.3.1 Domestic Flights

In some airports the boarding passes are electronically scanned by a boarding pass reader as the passengers enter the aircraft. In such a configuration, the boarding pass scanner can be interfaced to the ticket system and the state of aircraft boarding can be readily determined. In manually operated systems, the passenger count is used to determine when all passengers have boarded the flight and the aircraft is ready to depart. In the event of a mismatch, a more stringent approach is taken and the boarding passenger list is checked to determine who is missing so that the airline can page the traveller for a last call boarding announcement. On domestic fights the requirement for baggage reconciliation is relaxed and there is no need to delay the departure of the aircraft if the baggage and passenger are not both on the same flight.

2.6.6.3.2 International Flights

For international flights the passengers boarding an aircraft will be checked against the passenger list that has been compiled from the passenger checked-in on the flight. Security requires the number of passengers checked in on the flight to be matched with the number of passengers boarding and with the number of checked bags loaded onto the aircraft.

If there is a discrepancy, a more intense check is made of the passenger list and the checked baggage list and the two are reconciled before the flight can depart.

3 SECURITY EQUIPMENT TYPES

3.1 Introduction

The single largest problem area for airport security systems is the lack of standard interfaces and data interface exchange formats on many of the systems used for airport security applications. Not one piece of equipment has an interface that is compatible with any piece of equipment from a different manufacturer. In some cases, no interfaces can be readily accessed by electronic means to read out, download, or even sense alarm conditions from that system.

The other issue with integrating security systems in airports is the inability to remotely identify individual passengers in the concourses of the airport and to locate or note when passengers cross protection barriers. At this time there is no practical, low cost way of determining the identity of the person carrying the boarding pass through a security interface.

Without some way of tracking the identity and movement of the passenger through the security barriers and the boarding gate onto the aircraft, there is no way of confirming that the identity of the ticket holder and the departing passenger are the same individual. The acquisition of passenger images and boarding pass information as individuals pass through the various security barriers would complete the tracking of passengers, their associated baggage, and possibly their carry-on baggage.

Various types of security equipment and processes are used to implement the security features and functions required for passenger and aircraft security. In the following subsections, a brief discussion of technology will be followed by equipment found at each checkpoint location.

- Ticket Purchase
- Check-in Counter Security Equipment
- Passenger Screening
- Checked Baggage Screening
- Boarding Gate Security
- Baggage Reconciliation

3.2 Discussion

In US and Canadian airports, the various pieces of baggage checking equipment operate as stand-alone systems. However, there may be interfaces between some of the BEDS scanning systems and the operator-manned terminals used to check in detail any questionable items discovered in the checked baggage. These operator interfaces are required for Level 2 checking of baggage and are always unique to the systems that perform the initial baggage scan. The automated functions in the BEDS systems look for any restricted items that are detected and need further investigation by operator-manned workstations.

When BEDS scanning systems are integrated into automated baggage handling systems, the scanned bags are automatically evaluated by the hardwired baggage handling system. If no suspect signals are detected from these bags, the BEDS scanning and data processing hardware signals the automated baggage handling system to continue transporting the bag to its intended destination flight. On the other hand, if suspect material signals are detected and the operator does not make a decision in the allocated time, or if the bag's tag is misread, the baggage handling system will divert it to a Level 3 inspection station for further evaluation. Because the automated baggage handling needs to scan the ID/Routing tags on the individual bags for the routing information, there is a possibility for these systems to feed back the current location and destination of the baggage to a centralized database for integration into an overall security system. This data is currently not fed back to any systems other than the automated baggage handling system.

3.3 Interfaces

The various interfaces on the airport security sensor equipment can be integrated into a system by having custom interface hardware designed and built to perform this function, or by having the equipment manufacturers design and build in the standard interfaces for such systems. Having the equipment manufacturers provide standard interfaces with a defined command and data response structure would go a long way in permitting diverse systems to communicate with each other and with central command and control systems. This approach would take several years to implement, but within a reasonable period of years the installed systems would be able to respond to external requests for data and be able to request data or other status information from the command and control system.

Current security systems in airports have no universal interface that can be adapted to a common standard. What can be done at this time is to have custom interface hardware designed and developed that will be able to acquire the required data and transmit that data to the master control system or an airport security system database in a format suitable for the application. Because of the large number of systems that might potentially be integrated into an airport-wide system, a communications capacity capable of transporting all the raw data to central databases without undue delay or processing bottlenecks would be needed.

3.4 Ticket Purchase

3.4.1 Introduction

The purchase of the ticket for travel on airlines is constantly changing and being automated. Today the ticket can be obtained in many different ways:

- travel agency;
- airline sales office;
- airline ticket counter;
- internet sources;
- telephone sales organizations; and
- automated ticket dispensers at airport.

With the ability to purchase of tickets by these various means, there are now an equal number of types of tickets:

- standard airline ticket;
- swipeable airline tickets;
- E-tickets (Electronic air pass);
- kiosk check-in – boarding pass only;
- fax confirmation letter;
- reservation number only;
- smart cards; and
- Travel Pass cards.

Ticket data is now generally confirmed by external documentation such as a FAX copy, smart card, or just a reservation confirmation number of the flight and ticket information. Each of these payment methods is different in concept and approach. These various ticket-selling methods are intended to meet the needs of the travelling public. The most traditional approaches are still in use by the travelling public in that the travel agent or the airline ticket counter makes the transaction.

In all cases, the data for the ticket, the passenger, and the flight is held in the airline reservation computer system. This data is manually or automatically recalled when the traveller interacts with the boarding systems. Regardless of the approach used to purchase and pay for the ticket, the airline reservation system is being used to provide the data that permits the traveller to clear passenger security checks and gain entry to the aircraft for travel.

3.4.2 Ticket Terminals

3.4.2.1 Description

The ticket terminals that access the airline reservation system are generally a standard Personal Computer (PC) running Windows 95 or NT and the airline database access programs. In addition to the standard computer hardware, a ticket imprint device and a printer are all that is needed.

The Ticket Terminals need to access various airline reservation systems and be able to transfer and process this data that is in IATA-format PNL/ADL.

3.4.2.2 Integration Capabilities

The ticket reservation terminal is connected through a LAN/WAN network access arrangement to the airline system database. The airline computer reservation system will grant access to the required level based on the terminal access codes and authorizations granted. Communications can be either direct phone-in using a modem interface or they can be direct LAN connections to the network routers and gain access this way. In any configuration, the network interface is generally in a standard data interface protocol defined by IATA and other industry protocols.

3.4.2.3 Conclusion

Integration of this system into an airport security system can be implemented using the standard airline industry interface protocols and obtaining permission to access the required information.

Access to the required information may be more of an issue because of airline reluctance to share this type of customer data with other systems over which they have little or no control. This issue of protecting their database access and data control functions will be difficult to overcome.

Technically, there is no barrier to obtaining the ticket data and linking it to the security data generated at airports by the travelling public.

Integration of the ticket and passenger data into the airport security system could be accomplished in a straight-forward data interchange process, with the airline reservation system permitting a full-time data connection to exist to exchange the pertinent data that applies to the specific airport. The filtered data for travellers could be forwarded or requested as it is needed or becomes available. This data would permit the linking of passenger identification, the potential profile data, and the numbers associated with any checked baggage for a specific passenger. Using this data would then permit the airport security system to link the pertinent data and would make data fusion possible.

3.5 Check-In Counter Technology

3.5.1 Check-In Counter Terminals

3.5.1.1 Introduction

The check-in counter equipment is generally just a reservations system terminal, a boarding pass printer, a checked baggage tag printer and a checked baggage scale. This equipment is used to confirm the arrival of the passenger at the airport in preparation for departure and the tagging of the checked baggage for identification and routing to its destination. The reservations terminal is used to generate the boarding pass information, log the passenger's arrival and personal preferences, and confirm the ownership of proper travel documents for international destinations.

3.5.1.2 Description

The reservation terminals that access the airline reservation system database are generally a standard Personal Computer (PC) running Windows 95 or NT with a terminal control program or a custom terminal with proprietary hardware and software to access the airline database access programs. In addition to the standard computer hardware, a ticket imprint device and a printer are all that is needed. This terminal could also feed data to the airline boarding control system (could be integrated with the ticket reservation system) so that aircraft boarding data and passenger lists can be generated.

This check-in counter passenger data is co-ordinated with the passenger checked baggage tracking and ticket verification data. This process can be used to ascertain the aircraft seat assignment, loading status, load factors and other data that is often required to speed passenger loading and aircraft departure processes. The data for these applications can be accessed and entered from multiple sites such as:

- check-in counter;
- baggage handling system;
- boarding gate(s);
- automated ticket kiosks;
- smart card terminals.

3.5.1.3 Integration Capabilities

As with the ticket reservation terminals, the integration of this system into an airport security system could be implemented by using the standard airline industry interface protocols and obtaining permission to access the required information.

Technically, there is no barrier to be resolved to obtaining the ticket, passenger, and checked baggage data and linking this data to the security data generated at airports by the travelling public.

3.5.1.4 Conclusions

Passenger boarding data can be derived from the airline departure control system, or the airline ticket reservation database. The ability to link the data from many sources for data fusion purposes will be critical to implementing a full-featured airport security system so that an enhanced security system could be implemented.

Access to the required information may be more of an issue because of airline reluctance to share this type of customer data with other systems over which they have little or no control. This issue of airlines protecting their database access and data control functions will be difficult to overcome.

Technically, there is no barrier to obtaining the ticket data from the airline reservation database or the airline departure control system and linking it to the airport security system to the data generated at airport security checkpoints or other data sources.

3.6 Passenger Security Checkpoint Equipment

3.6.1 Introduction

At all airports for all commercial flights, passengers and carry-on baggage are inspected for prohibited items. This passenger screening is implemented by manual inspection, X-ray scanning of all carry-on baggage, and using magnetic anomaly detection equipment to detect metallic components and materials carried on a passenger's person.

3.6.2 Passenger Screening Equipment

3.6.2.1 CEIA 02PN10 Security Metal Detector

3.6.2.1.1 Description

The Metal Detector is the workhorse and foundation upon which passenger screening is based. It is characterized by having the electronics unit integrated into the gate hardware. The 02PN10 is a high performance detector for airports and other high security applications. It uses a unique system of variable magnetic field generation and receives signal analysis based on an innovative concept of recognition and exclusion of electrical interference. The uniformity of the field using this method allows clear-cut discrimination between compact masses of metal such as weapons and personal objects such as keys and coins. Concealed weapons can be intercepted in velocity ranges up to 15 m per second without a variation in sensitivity.

3.6.2.1.2 Integration Capabilities

The walk-through metal detectors have data interfaces that would permit them to be configured and hooked together to communicate the detection of metal passing through the gate. In addition, there are relay driven contacts that signal the detection of metal moving through the metal detector gate.

3.6.2.1.3 Conclusion

The walk-through metal detector has the interfaces required to detect the passing of metallic components that exceed the pre-set threshold. These signals and alarm contacts can be used to signal to a data acquisition system that a potentially prohibited metallic item is in the magnetic flux field of the detector.

This interface would require a data translation device to convert RS-232 and contact closure events into a network capable interface and data format. In addition, at some time it would be necessary to add biometric information or some other unique identifying data on the person passing through the metal detector.

The detection of metal on a person walking through the security metal detector is not useful by itself without identification data or passenger ticket number passing through the metal detection system, so that the data can be linked together for future data fusion applications.

3.6.2.2 Hand-Held Superscanner Metal Detector

3.6.2.2.1 Description

The hand-held portable, battery-operated, magnetic flux gate metal detector is used to sense and detect metallic items on a person. This device generates a varying magnetic flux on the sensing end of the scanner and measures the decay of the field when it is turned off. If there is magnetic material in close proximity to the field, a variation will be detected in the field when it decays. This change in the decay of the magnetic field is what is used to sense metal objects.

The most common device for this application is the **Garrett Metal Detectors model Superscanner** as described in Appendix D.

3.6.2.2.2 Integration Capabilities

In general, the hand-held metal detector has no electronic interface that can be network connected. This lack of interface should not be an issue, as a security person is in control of the instrument and there is no critical need to have this interface linked to an external system. The walk-through metal detector has already signalled that the passenger has excess metal on their person before the hand-held wand metal detector is used to perform additional checking of the trigger condition.

3.6.2.2.3 Conclusion

This device does not need to be integrated, as it is a utility tool used by security personnel at passenger screening barriers for secondary checks only. In addition, the hand-held metal detector cannot be readily integrated into a network.

3.6.2.3 Carry-On Baggage Screening Security Equipment

3.6.2.3.1 Introduction

As in the case of the passenger screening requirement, at all airports for all commercial flights, passengers and carry-on baggage are inspected for prohibited items. Passenger screening is one approach used to prevent the carrying onboard of aircraft restricted items such as knives or guns. This screening process is implemented by manual inspection and X-ray scanning of all carry-on baggage.

3.6.2.3.2 HI-SCAN 6040-A X-ray Scanner

Description

The Heimann Systems Hi-Scan 6040-A is an X-ray machine designed to inspect carry-on baggage and other small items. The Hi-Scan 6040-A has an X-ray tube that generates a fan-shaped beam that scans a slice of the baggage as it moves through the beam on the conveyor belt.

The image of the item under inspection is generated as the signals from the L-shaped detector array of 684 photo diodes are detected and processed. A new scan is taken for every 1 mm of physical motion of the item under inspection. Each scan (slice) of the item under investigation is processed, and the results are presented on a colour or black and white display for viewing by the operator. This system is film-safe up to 1600 ASA.

Integration Capabilities

The Heimann Systems Hi-Scan 6040-A carry-on baggage scanner has no direct data export interface. Heimann sells an interface unit called "PC-STORE" as an option that needs to be installed into each X-ray unit. This optional interface unit can then retrieve, store, and transfer on command the stored X-ray images to a standard PC, over a network card such as 10/100 Ethernet. At the destination PC system, these images can be converted into standard formats using OTS_LINK software.

An alternative approach to installing the "PC-STORE" is to design a custom product that can interface to the Hi-Scan 6040-A and perform the video image conversion and interface to the LAN for transmitting the image data. This design would use a scan converter to digitize the colour or black and white video signal on the monitors to digital video format suitable for transmission over a network. In addition, at some time it would be necessary to add information on the identity of the owner of the bag being scanned. This information may be unique or could be of a generic nature.

Conclusion

With the addition of the "PC-STORE" product from Heimann Systems and the addition of the LAN interface implemented in either software or hardware, the Hi-Scan 6040-A carry-on baggage scanner could be interfaced to a standard LAN/WAN communications network with a database server to organize the video data.

It would be expedient to add an additional interface box so that the video data could be associated with the carry-on baggage ticket ID of the owner. In this way, it would be possible to associate ownership of the baggage in question.

This additional function of identifying the carry-on baggage would require some additional ticketing procedures at the passenger security gate check.

3.6.2.3.3 HI-SCAN 6040i X-ray Scanner

Description

The Heimann Systems Hi-Scan 6040i is similar to a Hi-Scan 6040-A, upgraded with additional interfaces. The Hi-Scan 6040i is an X-ray machine, designed to inspect carry-on baggage and other small items. The Hi-Scan 6040i has an X-ray tube that generates a fan-shaped beam that scans a slice of the baggage as it moves through the beam on the conveyor belt.

Integration Capabilities

The Heimann Systems Hi-Scan 6040i X-ray scanner is the same as the 6040-A, with the addition of an Ethernet port (i.e., the HI-TRAX option). The 10baseT Ethernet port allows video images to be retrieved by a remote system on the LAN network. The images are encoded in a Heimann proprietary format. As with the 6040-A, an RS-232 port is available for diagnostics.

In addition, the VGA output video signals could also be captured so that the carry-on baggage scan results could be appended to the passenger profile.

Conclusion

The Heimann Systems Hi-Scan 6040i X-ray scanner can be connected to the network directly but the interface to the database system would require custom software to interrogate the video pictures from the machine. It may also be possible to use an external PC type system to perform the data transfer and move the resultant data to the host database system in the format desired with the identifying information attached.

It would be expedient to add an additional interface box so that the video data could be associated with the carry-on baggage ticket ID of the owner. In this way, it would be possible to associate ownership of the baggage in question under view.

This additional function of identifying the carry-on baggage would require some additional ticketing procedures to be added to the passenger security gate check functions.

3.6.2.3.4 InVision CTX 5000 SP

Description

The InVision model CTX 5000 SP is an X-ray machine using computed tomography (CT) technology for image enhancement and improved detection capabilities. The initial X-ray image results determine how many CT slices should be made and where to inspect the baggage in greater detail and accuracy. The CT slices are automatically analyzed for explosive and other prohibited materials. The CT scanned slices are used to help detect thin sheet explosive material in particular. Baggage can be scanned at an average rate of 150 bags per hour in the US and 240 bags per hour in Europe. This rate takes operator decision time into account. The average false alarm rate is in the 20-30 percent range in an automated operation.

The InVision model is generally used for checked baggage, but can also be used for carry-on baggage screening. The CTX 5500 DS is InVision's second generation of BEDS scanning system. This system is an enhanced version of the CTX 5000 SP, FAA-certified, automated explosive detection system (EDS), designed to screen checked passenger baggage. CTX systems combine transmission X-ray, CT, and sophisticated automatic inspection software to provide the highest available detection probabilities of prohibited materials.

Integration Capabilities

The CTX 5000 SP has a modem, VGA port, and 64 contact closures that could be used to communicate the threat status of baggage. The contact closures are for communication with the airport's programmable logic controller (PLC) which controls the baggage conveyor. The modem operates at selectable data rates between

9.6 kbps and 33.6 kbps. It is unknown for what services that modem provides access or exactly how the data gets to the Level 3 workstations.

The Level 2 workstation is directly attached to the CTX 5000 SP scanner. The VGA output could be captured so that the data could be converted and network interfaced to a LAN for data monitoring and downloading. As in the case of all carry-on baggage scanners, at some time it would be necessary to add information so that the identity of the owner of the checked baggage being scanned could be determined. This information may be unique or could be of a generic nature.

Conclusion

The CTX 5000 SP X-ray scanner could be connected to a LAN, but the system would need to be interrogated for the video image data so that it could be stored in a security database system for future retrieval.

To link the associated video images with a passenger, the system should be able to read the ID tag on the checked baggage that it has scanned for prohibited items. In this manner it would be able to associate the video image of a particular bag with a passenger.

3.6.2.3.5 InVision CTX 9000DSi

Description

The InVision CTX 9000 DSi has been FAA certified (about May 1999) as a checked baggage scanner (BEDS) capable of being used as a carry-on baggage screening system. The CTX 9000 DSi combines the low false alarm rates and high detection rates of the CTX series with a number of significant enhancements and new features. The new CTX 9000 DSi machine offers very high image resolution for enhanced object examination by system operators. It also has the widest aperture of any certified checked baggage screening device, which allows for easier integration with baggage handling systems in airports. Initial evaluation testing will be performed at San Francisco International Airport. Little if any data is available for this machine and its performance characteristics.

Integration Capabilities

The InVision model CTX 9000 Scanner, it is *assumed*, has a 10 Megabit, a 100 Megabit Ethernet, or a 100 Megabit FDDI communications interface that could be utilized to download images of the scanned baggage in near real-time.

At this time little information is available on this machine's data interface capabilities. As it is being used in a BEDS application, it will in all *probability* have communications interfaces and data transfer protocols built in, to permit external operator workstations to view the scanning results. This interface could be utilized to permit the transfer of the scanned image data into a central airport security system database.

Conclusion

If the brief description data available can be extrapolated, the reconstructed baggage image data could be retrieved for record keeping in an external database. It is assumed that this machine will need some external interface function to permit the unhindered readout of the scanned video image data.

As in all of the other machines mentioned for checked baggage scanning use, the direct video image to the monitors could be digitized and signal processing and compression functions implemented to permit the transfer of this data to the security database for record keeping. This back-up mode of operation is always available should other approaches not be workable.

As in the case of all carry-on baggage scanners, at some time it would be necessary to add information so that the identity of the owner of the checked baggage being scanned can be determined.

3.7 Checked Baggage Screening Security Equipment

3.7.1 Introduction

Existing commercial X-ray scanners are capable of giving high-resolution images of the interior of objects. They have been used for many years to check hand-carried baggage and, more recently, checked baggage. During the last five years, major strides have been made in X-ray technology. New models offer significantly greater capabilities than those in general use at airports today. Some of these new systems can now differentiate between materials composed of light or heavy elements, and some offer very good resolution with three-dimensional imaging capability. In general, X-ray systems are under development and reaching FAA certification testing by established, large or mid-sized commercial manufacturers and these systems represent modifications to their current products. Consequently, new X-ray systems can be brought to market much more rapidly than most of the other devices under development.

The most important new developments in X-ray systems are in the areas of:

- dual or multi-energy transmission X-ray systems;
- backscatter X-rays; and
- CT X-ray.

Dual or multi-energy transmission X-ray systems can distinguish between low and high Z (or atomic number, the number of protons in a given nucleus) elements to a degree and can present the viewer with two or more images that emphasize the different materials by, for example, colour differentiation.

Commercial devices with this capability are produced by:

- EG&G Astrophysics;
- InVision Technology Inc.;
- L3 Communications Inc.; and
- Siemens-Heimann.

A somewhat different approach to explosives detection systems (EDS) in checked baggage is represented by the Z-Technology (a trademark) or backscatter X-ray system, developed by American Science & Engineering (AS&E). In this case, the low Z image is created by a process of detection of Compton backscatter radiation. Commercial Z-Scan systems exist, and the manufacturer is now attempting to develop an automated pattern recognition approach that will meet the FAA's EDS requirements. Discrimination between high and low Z, although useful, does not specifically and uniquely identify explosives.

CT X-ray analysis is used by L3 Communications and InVision Technologies to provide three-dimensional spatial resolution of the baggage under observation. In CT, a ring of detectors surrounds the target object. The X-ray source is rotated around the detectors, and numerous X-rayed images are recorded and used to reconstruct a representative three-dimensional image of the object. This technology is used in the eXaminer 3DX6000 from L3 Communications and InVision's 9000 series of products. These devices combine both dual energy X-ray and CT technology to detect hidden explosive materials in checked baggage.

3.7.2 Heimann Systems Hi Scan 10050 EDS

3.7.2.1 Description

The Heimann Systems Hi-Scan 10050 EDS is similar in operation to the Hi-Scan 6040-A upgraded with additional interfaces and functions. The Hi-Scan 10050 EDS is an X-ray machine designed to inspect checked baggage with capability to inspect carry-on baggage and other small items. The Hi-Scan 10050 EDS has an X-ray tube that generates a fan-shaped beam that scans a slice of the baggage as it moves through the beam on the conveyor belt.

The image of the item under inspection is generated as the signals from the L-shaped photo detector array is detected and processed. A new scan is taken every 1 mm of physical motion of the item under inspection. Each scan (slice) of the item is processed and the results are presented on a colour or black & white display for viewing by the operator.

3.7.2.2 Integration Capabilities

The 10050 unit has an interface that permits it to be hooked up to a standard, "off the shelf" computer system. This results in a variety of networking options being viable for reading out the scanned image data into a central security database. As with all Heimann systems, the data is stored in a proprietary Heimann format. Software conversion utilities are available that can convert this image format to a standard image format.

3.7.2.3 Conclusions

This X-ray BEDS scanner would require interface hardware for data translation and network interface connections. In addition, at some time it would be necessary to add bag identification data so that the scanned image data can be retrieved from the airport security system database and associated with other security information.

In addition, it would expedient to have a checked baggage tag reader mounted so that the routing tags on the baggage could be read out and the associated X-ray image could then be connected to a passenger or a ticket number for tracking and data fusion.

NOTE: The Heimann X-ray systems have interface capability using an external box to retrieve and convert the X-ray image data for transmission to operator training stations. This capability can also be used to convert the regular image data for conversion into the format required for the ASDF database system. This needs to be investigated further if a technology demonstration system is implemented. This hardware approach could be used along with other processing hardware to log all checked baggage X-ray scanned images. This hardware function is further described in the Heimann manuals "Operator Training System OTS 1" description and installation manual. The function is part of the optional system "PC-STORE" product from Heimann Systems. With the addition of the LAN interface implemented in either software or hardware, the Hi-Scan X-ray system carry-on baggage scanner could be interfaced to a standard LAN/WAN communications network with a database server to organize the video data.

3.7.3 AS & E 101ZZ

3.7.3.1 Description

The American Science and Engineering 101ZZ is an X-ray scanning system that uses multiple sensor technologies to collect transmission and backscattered X-ray signals to build images of the contents of checked baggage. Transmission images are obtained from energy that directly penetrates the baggage, whereas backscatter images are obtained from energy that did not penetrate the baggage and was scattered back towards the X-ray source. The 101ZZ gathers both transmission X-ray data and the backward scattered X-ray signals to create an image of the baggage contents. Combining all three sensor modalities can improve the probability of explosives detection and reduce false alarm rates. The AS&E system uses a unique method of generating the scanning X-ray beam by using a "flying-spot" technology, which provides very high quality X-ray images from all three sensors. Despite its advantages over conventional systems, "flying-spot" technology has never been fully explored in airport security for automated explosives detection.

The 101ZZ system provides very limited automated explosives detection features and requires complete manual control to enhance the image to detect hidden explosives or other contraband materials. Data collection and analysis is performed manually through the operator control panel.

3.7.3.2 Integration Capabilities

The interfaces on the AS&E 101ZZ are standard I/O, such as printer and RS-232 for data. There is a video interface to the monitors for viewing the detected signals from the baggage under investigation. These interfaces do not readily lend themselves to interfacing directly to a network.

3.7.3.3 Conclusion

The AS&E 101ZZ could be interfaced using a custom interface box that will accept the VGA type signals from the monitor connection along with some signal from the electronics to indicate that the baggage has been scanned and the picture is available for conversion. This interface box would then be connected to the LAN to permit the transmission of the image data to a central database for record keeping.

As in the case of all carry-on baggage scanners, at some time it would be necessary to add information so that the identity of the owner of the checked baggage being scanned could be determined. This data could be retrieved from the bag under observation by reading the routing tag on the bag and thereby get the associated ID of the owner or the ticket by which the passenger is identified.

3.7.4 EG&G Astrophysics Z-SCAN 7

3.7.4.1 Description

The EG&G Z-Scan 7 is a two-view, dual-energy automatic X-ray system with a tunnel opening 1 m wide by 800 mm high. It is designed to be either integrated into the baggage conveyor system for hold baggage screening at airports, or used as a stand-alone unit behind the check-in counters at the airports. In the stand-alone mode, the Z-Scan 7 has the capability of screening normal-sized as well as out-of-gauge parcels.

In an automatic mode the Z-Scan 7 processes, on the average, 1000 bags per hour when operating as part of the baggage conveyor system for hold baggage screening. In this mode, the Z-Scan 7 operates as a Level 1 to Level 2 system where the Level 2 is either an operator evaluating images of rejected bags in a remote operator room, or a CTX machine receiving the rejected bags from the Z-Scan 7 for further evaluation. If the Z-Scan 7 is in a stand-alone mode, it processes, on the average, 350 bags per hour.

3.7.4.2 Integration Capabilities

The Z-Scan 7 has a 100 Mbit/s Ethernet connection that communicates the scanned baggage image data to the Level 2 and Level 3 workstations. It is believed that this connection could be used to archive the image data into a central database for security applications. As in all other applications, the image data may be stored in a proprietary format. A LAN hardware interface may be required to permit the Z-Scan 7 image data to be transferred to the networked security system database.

The 100 Mbit/s Ethernet connection can be either UTP or fibre optic cable.

3.7.4.3 Conclusion

The 100 Mbit/s Ethernet communications interface could be connected to a LAN (10BaseT) through a smart adapter and compression hardware so that the data intercepted from the X-ray scanning hardware on the way to the display/control terminal could also be sent to a security system database. An alternative approach is to interface the VGA/SVGA video signal to the LAN through an adapter box that detects the image data and stores it before sending the processed video data to the database server for storage.

In the Z-Scan 7 X-ray scanning machine, this communications interface may only transfer data if the automated explosives detection algorithms detect a prohibited material and operator intervention is required.

The video capture mode of operation and interface to the LAN is another option to consider. In any situation, the video image data can be intercepted and converted for use by a security system database.

As in the case of all checked baggage scanners, at some time it would be necessary to add information so that the identity of the owner of the checked baggage being scanned can be determined.

3.7.5 EG&G Astrophysics Z-SCAN 12

3.7.5.1 Description

The EG&G Astrophysics Z-Scan 12 is a medium-sized, automatic X-ray system typically used to screen hold baggage at airports. It can also be used in the concourse of airports for the checking and screening of passenger carry-on baggage.

The EG&G Astrophysics Z-SCAN 12 operation is based on a two-view, dual-energy, automatic X-ray scanning technology. The dual-energy scanning system works by merging the data from a horizontal and vertical X-ray beam scan. Through the merging of these two images, a three-dimensional density map of the target can be formed and light elements such as carbon, oxygen, and nitrogen can be easily detected. Dual-energy scans provide more information than standard X-ray scans because they can help differentiate between very little of a highly absorbent material and a lot of a low absorbent material.

Very little information is available on the method of operation and on the interfaces available for video picture readout.

3.7.5.2 Integration Capabilities

Not known.

3.7.5.3 Conclusion

No conclusion can be drawn because of lack of information.

3.7.6 InVision CTX 5000 SP/CTX 5500 DS

3.7.6.1 Description

The InVision CTX 5000 SP operation is based on X-ray and CT technology. The X-ray results determine how many CT slices are to be made and where to accurately inspect the baggage. The CT slices are automatically analyzed for explosive materials. The CT scanned slices are used to help detect thin sheet explosive material.

The CTX 5500 DS is InVision's second generation of BEDS scanning system. This system is an enhanced version of the CTX 5000 SP, FAA-certified, automated explosives detection system (EDS), designed to screen checked passenger baggage. The CTX 5500DS has the same X-ray hardware as the CTX 5000 SP, but has improved data processing capacity and runs enhanced image processing software. The CTX systems combine transmission X-ray, CT, and sophisticated automatic inspection software to provide the highest detection available.

Improving upon the performance of its predecessor, the CTX 5500 DS is the first "intelligent" EDS to be developed for checked baggage screening. This intelligence is applied to both the automatic and operator inspection processes. It provides airports with the ultimate screening flexibility and can be configured to automatically detect narcotics.

Dynamic Screening™ allows CTX to automatically monitor the security status of each bag via a direct interface with the airport's baggage handling system. CTX then automatically selects the appropriate screening software on a bag-by-bag basis by considering the level of suspicion and the number of bags waiting in the queue.

3.7.6.2 Integration Capabilities

The CTX 5000 SP and the CTX 5500DS have a modem, VGA video port, 64 contact closures to communicate the threat status of baggage to the automated baggage sorting machines, and a 10 Mbit/s Ethernet interface. The contact closures are for communication with the airport's programmable logic controller (PLC), which controls the baggage conveyor. It is unknown to which services that modem provides access or exactly how the data gets to the Level 3 workstations. The Level 2 workstation is directly attached to the scanner. The VGA output could be captured so that the baggage scan results could be appended to the passenger profile.

3.7.6.3 Conclusion

There is no exact description of the 10 Mbit/s Ethernet interface protocol, but if used to communicate the video image data to the Level 2 or Level 3 operator terminals, this interface could then be used to acquire the video image data in a custom interface that acquires the digital data and processes it for transmission over a standard Ethernet LAN to the security system database server.

A back-up mode of implementation could be to perform a video capture operation of the video terminal signals and interface this to the LAN. In any situation, the video image data can be intercepted and converted for use by a security system database.

As in the case of all checked baggage scanners, at some time it would be necessary to add information so that the identity of the owner of the checked baggage being scanned can be determined.

3.7.7 InVision CTX 9000 DSi

3.7.7.1 Description

The CTX 9000 DSi has been FAA certified at a baggage throughput rate of 542 bags per hour, making it the fastest certified EDS in the world. The CTX 9000 DSi combines the low false alarm rates and high detection probability rates of the CTX series with a number of significant enhancements and new features. The new EDS offers very high image resolution for enhanced object examination by system operators. It also has the widest aperture of any certified checked baggage screening device, which allows for easier integration with baggage handling systems in airports.

3.7.7.2 Integration Capabilities

The CTX 9000 has a communications interface that is listed in the 1998 corporate annual report as a high-speed data link with fibre optic connections. This interface(s) *may* be a standard LAN interface to either 10BaseT, 100 Mbit/s or a 100 Mbit/s FDDI link. It is *presumed* that this interface either connects the control and monitoring terminal to the X-ray scanner or is used for external interface for control and remote access to the processed data for operator intervention on questionable scanned materials. It could be utilized to download images of the scanned baggage in near real-time. This interface, if so applied, could be coupled to a smart network adapter and retrieve the image data and compress it for transmission to the security monitoring database. The data on the network link from the X-ray scanning hardware to the operator display/control terminal could be monitored for the X-ray image and ID tag data so that an image of the baggage under observation could be sent to the ASDF database. An alternative approach is to interface the VGA/SVGA video signal on the display/control terminal to the LAN through an adapter box that detects the image data and stores it before sending the processed video data to the database server for storage.

At this time, little information is available on this machine as to its data interface capabilities. As it is being used in a BEDS application, it will in all *probability* have communications interfaces and data transfer protocols built-in to permit external operator workstations to view the scanning results. This interface should be used to permit the transfer of the scanned image data into a central security database.

3.7.7.3 Conclusion

If the brief description data available can be extrapolated, the reconstructed baggage image data could be retrieved for record keeping from an external database. It is assumed that this machine will need some external interface function to permit the unhindered readout of the scanned video image data.

As in the case of all carry-on baggage scanners, at some time it would be necessary to add information so that the identity of the owner of the checked baggage being scanned can be determined.

3.7.8 L3 Communications eXaminer 3DX6000

3.7.8.1 Description

The L3 Communications eXaminer 3DX 6000 incorporates CT scanning technology as well as detection algorithms for sheet-like forms of explosive, is capable of generating three-dimensional images of all objects in bags, and is a single-unit, second-generation system certified by the FAA.

The 3DX 6000 utilizes a dual energy, helical-cone-beam, multi-slice CT system that provides a complete set of CT images of an entire three-dimensional object as it passes along the baggage conveyor. The system includes a high efficiency, wide dynamic range, solid-state X-ray detector array consisting of 6048 detectors. Rotating at 90 rpm, this system takes up to 720 sets of 6048 measurement points per rotation every two-thirds of a second. The system presents both projection and axial images of this moving object for analysis by the operator.

Sophisticated software automatically isolates bag contents unambiguously and analyzes them, evaluating them against the known characteristics of explosives or narcotics. If a match is found, the system alerts the operator, highlights the area of concern for further analysis, and provides a full rotating 3-D image of the potential threat.

3DX 6000 Features:

- generates full 3-D images of all objects in every bag;
- gathers all necessary data in one pass;
- requires only 6 seconds per scan;
- isolates and analyzes the entire contents of each bag automatically;
- acquires ten times more data per bag than first-generation systems; and
- handles up to 600 bags per hour.

3.7.8.2 Integration Capabilities

The L3Communications-developed 3DX6000 eXaminer X-ray checked baggage scanner has several interfaces to external devices. The main network connection is the 100 Mbit/s FDDI interface in addition to a PCL I/O interface to the automated baggage handling systems. The final connection available is the RS-422 high-speed serial communications interface for unknown applications.

3.7.8.3 Conclusion

The FDDI communications interface could be connected to a LAN (10BaseT) through a smart adapter and used to compress the data intercepted from the X-ray scanning hardware on the way to the display/control terminal. An alternative approach would be to interface the VGA/SVGA video signal to the LAN through an adapter box that detects the image data and stores it before sending the processed video data to the database server for storage.

As in the case of all checked baggage scanners, at some time it would be necessary to add information so that the identity of the owner of the checked baggage being scanned can be determined.

3.7.9 Vivid Technologies VIS-M

3.7.9.1 Description

The Vivid Technologies VIS-M Automatic Level 1 functions are based on vertical beam, dual-energy X-ray technology. The dual-energy scanning works by merging the data from horizontal and vertical X-ray scans. Through the merging of images, a three-dimensional density map can be formed and light elements such as carbon, oxygen, and nitrogen can be easily detected. Dual-energy scans provide more information than standard X-ray scans because they can help differentiate between very highly absorbent material and low absorbent material.

The detector subsystem is an L-shaped array of 960 detectors. Approximately 500,000 pixels of data are obtained from each energy level for each scan as the item under observation passes through the machine. These pixels are grouped into tens of thousands of regions that are merged to form hundreds of objects. Each detected object's shape and thickness is electronically isolated, stored, and compared at high speed to a series of predetermined threat objects. Multilevel energy level comparisons of the data are performed to detect a wide variety of explosives and prohibited materials. The Level 1 system can automatically process a bag every 2.4 seconds or 1500 bags per hour. The system continuously monitors all safety interlocks and incorporates extensive self-tests to ensure proper operation.

3.7.9.2 Integration Capabilities

The Vivid VIS-M Level 1 BEDS X-ray scanner has an FDDI data interface which operates at 100 Mbit/s. When checked baggage is deemed suspicious, the relevant information is sent to a Level 2 workstation via the FDDI link for further evaluation and decision as to its resolution. If the baggage is not cleared in time, or further inspection is warranted by the Level 2 workstation operator, then the VIS-M machine automatically sends the bag to a Level 3 inspection station for a more detailed physical inspection

Little information is available from Vivid about this machine's data interface capabilities and data transmission format. As it is being used in a BEDS application, it uses the FDDI communications interfaces and data transfer protocols built in to permit remotely located operator workstations to view the X-ray scanning results where prohibited materials may have been detected. This interface should to be utilized to permit the transfer of the scanned image data into a central security database.

As in the case of all checked baggage scanners, at some time it would be necessary to add information to the scanned image data so that the identity of the owner of the baggage being scanned can be determined.

3.7.9.3 Conclusion

The FDDI communications interface between the X-ray hardware and the operator display/control workstation could be connected to a LAN (10BaseT or 100BaseT) through a smart adapter where the intercepted image and ID data could be compressed and sent to the ASDF System database. An alternative approach is to interface the VGA/SVGA video signal from the operator display/workstation video screen to the LAN and the ASDF System database. This adapter interface will need to detect the image data and process it before sending the data to the ASDF system database server for storage.

In the Vivid machine, this communications interface transfers data only if the automated explosives detection algorithms detect a prohibited material and operator intervention is required. In that case, the image data is sent to a Level 3 terminal for further decision-making input. This mode is therefore not readily useable for this application.

The video capture mode of operation and interface to the LAN is another option to consider. In any situation, the video image data can be intercepted and converted for use by a security system database.

As in the case of all checked baggage scanners, at some time it would be necessary to add information so that the identity of the owner of the checked baggage being scanned can be determined.

3.8 Boarding Gate Screening Security Technology

3.8.1 Introduction

The boarding gate equipment is generally a reservations system terminal, a boarding pass printer, and an automated boarding pass reader (if installed). This equipment is used to confirm, verify, or change the travel arrangements of passengers who have already cleared passenger security screening. The equipment that is installed at boarding gates is not required for security functions. The equipment located here is used to process the boarding passes relinquished by the passengers as they board the aircraft. It is limited to reservation terminals and in some cases, boarding pass readers, for confirming which passengers have passed the final checkpoint before leaving the terminal for their destination.

The boarding gate terminal equipment can be used to generate a new boarding pass if the passenger has just missed their flight or has different arrangements or preferences.

At some airports, automated boarding control is installed by the airlines to make the boarding process more accurate and faster. A boarding pass reader is placed at the gate to read the magnetic stripe on the back of the boarding pass. Based on the information contained on this "mag-stripe" the automated boarding control program decides whether the passenger is allowed to board the aircraft.

Automated boarding control normally runs on locally accessed computer equipment. It is possible to run this system on low-cost, stand-alone PC networked systems. This approach reduces system costs and can be installed virtually anywhere in the world. The automated boarding control system is normally independent of the departure control system mainframe (if installed), meaning that boarding can continue while either the mainframe or communication lines are down.

Automated boarding control constantly receives updates from the departure control system (if installed) and downloads to the central computer system the information on boarded passengers. In addition to tracking the boarding passengers onto the aircraft, the airline staff can determine the state of readiness for departure of the aircraft and this information can also be sent to the baggage reconciliation information system for international departures.

3.8.2 Terminal Equipment Description

3.8.2.1 Description

The boarding gate equipment is a terminal that accesses the airline reservation system. It is generally a standard Personal Computer (PC) running Windows 95 or NT and the airline database access programs. In addition to the standard computer hardware, a ticket imprint device and a printer may be attached. These terminals, in some cases, may be connected to the boarding pass readers. This data interface is not standard and has not been defined.

The ticket terminals need to access various airline reservation systems and to transfer and process this data, which is in IATA-format PNL/ADL.

3.8.2.2 Integration Capabilities

This equipment is fully integrated into the airline reservation system. It communicates to the airline system continuously when online. The integration of this system is already complete and would not require any additional work to complete.

3.8.2.3 Conclusions

The boarding gate terminal equipment is already integrated into the required airline reservation.

4 ASDF SYSTEM CONCEPT

4.1 Introduction

This section describes the overall system concept for an airport security data fusion (ASDF) System. This section is organized as follows:

- Needs and Requirements. This section describes the system needs and requirements at a very high level.
- System Overview. This section describes the purpose of the system, puts forth a concept of operations, and presents physical and functional architectures and a graphical user interface concept to illustrate the functions available to users.

4.2 Needs and Requirements

The *Interim Report for the Feasibility Study into the Fusion of Security Information from Existing Airport Security Equipment*, dated 9 November 1999, revealed several needs and requirements of an ASDF System. These needs and requirements are listed below, in no particular order. Any system implemented must:

- Be inexpensive;
- Be significantly better at detecting threats;
- Leverage existing investments in infrastructure;
- Increase security and throughput capacity;
- Be secure in and of itself;
- Be capable of interfacing to "external" agencies (see Figure 10);
- Reduce the use of security personnel;
- Implement automated viewing of alerts and alarms;
- Associate data from ticket issuance (such as name, etc.) with other sensor information and process data at the airport;
- Ensure that the person receiving the ticket/boarding pass is the one boarding the aircraft;
- Be capable of accepting data from or interfacing to the air carriers' reservation database (in a secure manner) and of segmenting the data by air carrier and group of carriers (i.e. Alliance partners);
- Be capable of accepting passenger profiling data (manual or CAPS);
- Associate travelling companions or associates;
- Associate all baggage including carry-on baggage;
- Be capable of including passport information;
- Be capable of recording video of each passenger at each checkpoint;
- Be capable of accessing, transmitting, and storing baggage sensor data in an information database;
- Increase the effectiveness and efficiency of checked baggage screening;
- Automate the baggage reconciliation process;
- Automate the transfer of data for in-transit passengers;
- Accept baggage loading data;
- Use standard LAN/WAN and computer resources technology.

4.3 System Overview

4.3.1 Purpose

The purpose of the system is to counter two basic threats to passengers – called Acts of Unlawful Interference:

- Taking control of the aircraft and passengers using items that are accessible within the passenger cabin, either weapons or explosives; and
- Placing explosives in the aircraft cargo hold.

4.3.2 Concept of Operations

The fundamental concept of the ASDF System is to network all data generating devices and store this data in a centralized database for operations. The physical and functional architectures are described below, as is the conceptual graphical user interface screen.

It is envisaged that a secure master control room would exist somewhere in the airport where passenger files could be viewed. Any alerts generated by equipment (i.e., X-ray detection of metal in a checked baggage) would be brought to the attention of the operator, who would then view all associated data in the database for that particular passenger. The operator would then take the appropriate action necessary to stop any acts of unlawful interference from occurring.

The operator would have the ability to send individual passenger files to local as well as remote authorities, so that the enforcement arm of the government could take the appropriate action. It is also expected that the local operator would be able to send passenger files to a destination airport master control station over a Wide Area Network (WAN). This would be particularly useful for processing in-transit passenger files.

4.3.3 Physical Architecture

4.3.3.1 Introduction

Figure 9 illustrates the physical architecture concept of the ASDF System. Each major element of the system is described below.

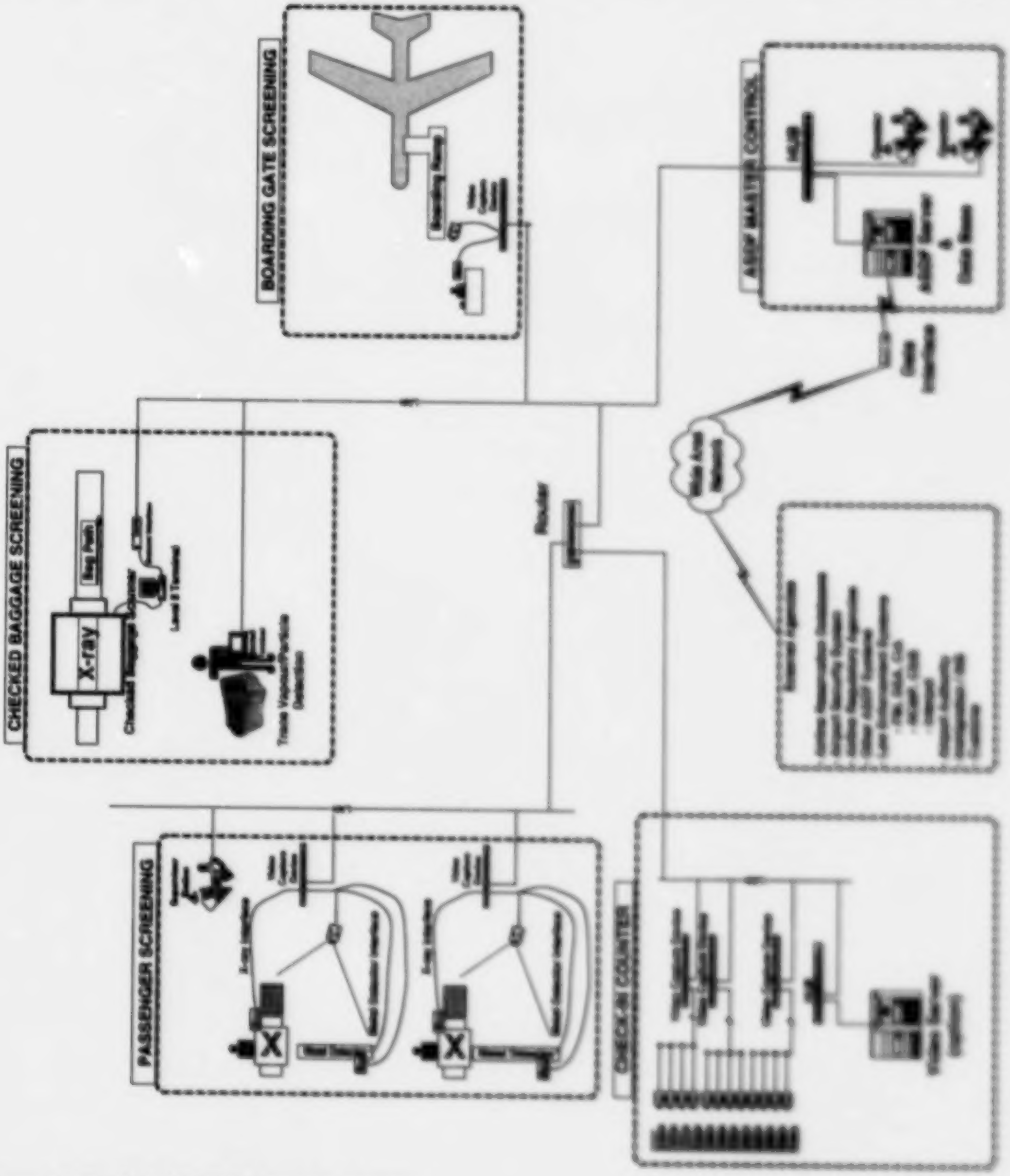

Figure 9 Physical ASDF System Architecture

4.3.3.2 Check-In Counter

The check-in counter consists of all the necessary equipment to interface to the ticket terminal equipment and to capture and digitize video (i.e., cameras and video compression and transmission units).

Communications should be via direct LAN connections to the network routers. In any configuration, the network interface should be a standard data interface protocol and defined by IATA and other industry protocols with permission to access the required information.

Integration of the ticket and passenger data into the ASDF System will be accomplished in a straightforward data interchange process, with the airlines reservation system permitting a full-time data connection to exchange pertinent data that applies to a specific airport. The filtered data would be forwarded or requested as it is needed or becomes available. This data would permit the linking of passengers, the potential profile data and the numbers associated with any checked baggage for the passenger. Using this data would permit the ASDF System to link the pertinent data and make data integration possible.

4.3.3.3 Checked Baggage Screening

The checked baggage ASDF System equipment consists of the hardware and software necessary to convert sensor data into a standard LAN protocol and format usable by the ASDF database and operating system software.

As discussed in the Report, checked baggage sensors have a wide variety of interface standards which are not, in general, compatible with the type of interface standard that would be used for an ASDF System. An interface unit would have to be designed and developed to leverage the existing infrastructure. Only one type of existing device should be used in the technology demonstrator.

Also, to accomplish the ASDF task, the bag identification and the X-ray data must be sent as a package to the ASDF database so that it can be associated with a passenger or a ticket number for tracking.

The Trace Vapour or Trace Particle test result could be entered using a standard terminal or data entry terminal with the required text form data.

4.3.3.4 Passenger Screening

The passenger screening ASDF System equipment would consist of the necessary hardware and software to capture data and video from the walk-through metal detector and carry-on baggage X-ray device. Data from any ticket/boarding pass readers should also be sent to the ASDF database so that video and sensor data could be associated.

The walk-through metal detector alarm contacts could be used to signal the video capture device to begin recording. This interface would require the use of a data translation device to convert RS-232 and contact closure events into network capable interface and data formats. Of the three devices analyzed, only one carry-on baggage X-ray device should be chosen for the technology demonstrator. It would be expedient to add an additional interface box so that the video data could be associated with the carry-on baggage ticket ID of the owner. In this way, it would be possible to tag ownership of the baggage in question. This additional function of identifying the carry-on baggage would require some additional ticketing procedures at the passenger security gate check.

The detection of metal on a person walking through the security metal detector is by itself not useable without the identification data of the person or his/her ticket number passing through the metal detection system so that the data can be linked together for future data integration applications. Therefore, a ticket/boarding pass reader would be required.

4.3.3.5 Boarding Gate Screening

The existing equipment is fully integrated into the airline reservation system. This equipment communicates to the airline reservation system continuously when online. The integration of this system is already complete and would not require any additional work. A ticket/boarding pass reader would have to be added to trigger the start of video capture.

4.3.3.6 ASDF Master Control

The master control and associated monitoring station(s) consist of the hardware and software necessary to control the ASDF System components and the viewing and control of the database. The major subsystems in master control would be a server, operating system software, database software, storage/archiving software, and graphical user interface software, as well as various expert systems software modules in the future.

4.3.3.7 Local Area Network (LAN)

The Local Area Network (LAN) technology would likely be based on 10BaseT or 100BaseT Ethernet technology. The most challenging work in this area would be the definition of a data protocol that permits the data from each of the sensors to be uniquely identified, controlled, and stored correctly. This would require that most sensors be programmed or interfaced to a programmable device (i.e., PC, PLD, etc.).

4.3.3.8 Wide Area Network

The Wide Area Network (WAN) will be based on standard telecommunications technology. To prevent security violations, a firewall and other appropriate security features would be required.

The Wide Area Network (WAN) would be used to receive data from external agencies and organizations. This configuration would permit the most secure approach to receiving data and pertinent warnings from external agencies about situations that may develop, based on intelligence and other sources. These links would generally be restricted and so would the access to the ASDF database system. This precaution would minimize access to passenger data from competitive airlines and prevent hackers and other unauthorized persons from accessing and disrupting the ASDF System.

4.3.3.9 External Agencies

Communications protocols with various external agencies should be defined so that two-way communications of data files could be accomplished.

For the ASDF System to operate, external agencies are not required to provide data. To have input from external agencies would provide more information on which to make a better judgement call on situations that may be developing at an airport with respect to the actions of passengers, contents of baggage, or the behaviour of visitors in the facility.

In the future, the availability of data from non-airline sources could the operation of the ASDF System.

4.3.4 Functional Architecture

4.3.4.1 Introduction

The functional architecture shows the ways by which data could flow inside the ASDF System. This data flow in part or in its full implementation is described in Figure 10.

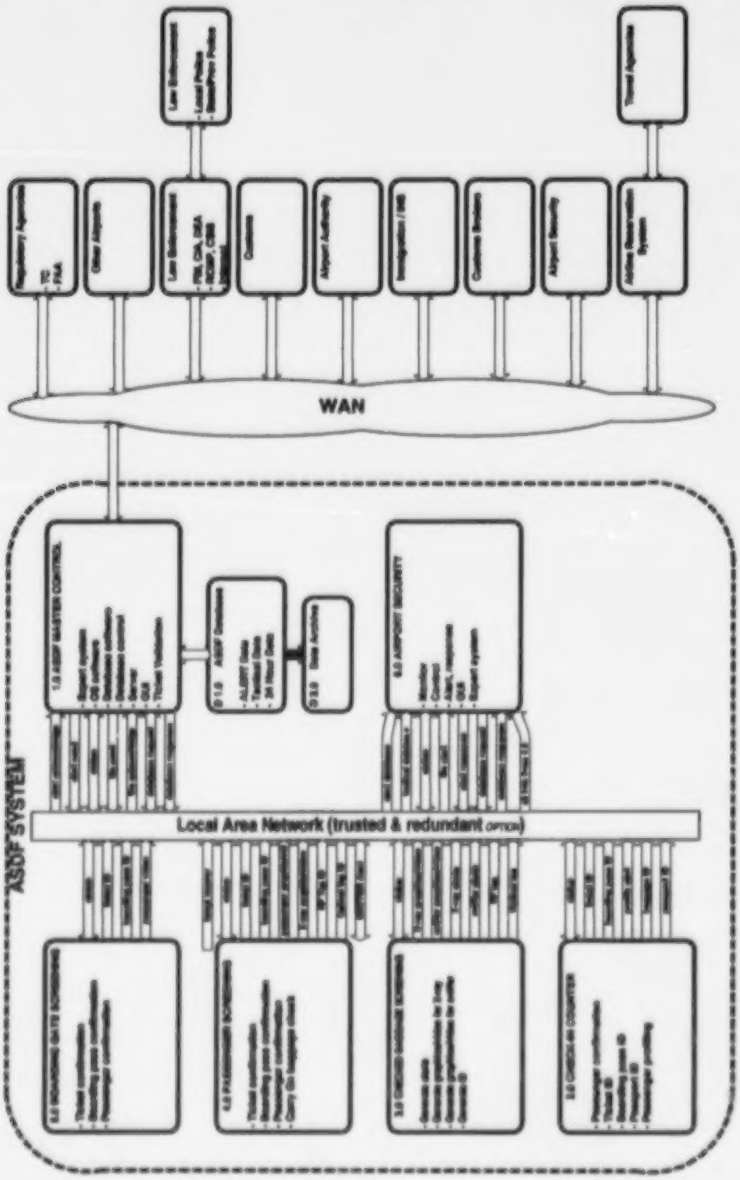

Figure 10 Functional ASDF System Architecture

4.3.4.2 Check-In Counter

At the check-in counter, the data that would link all the other pieces of data together is derived or generated. The following data would be gathered when the passenger with a ticket is served:

- passenger ID;
- passenger status;
- passenger profile;
- ticket ID;
- boarding pass ID; and
- baggage ID.

Various systems could use this information, with the associated video sequences, X-ray images, passenger screening data, and boarding data, to build a profile of the passenger risk.

At this station a passengers behaviour evaluation could be enhanced by recording the check-in process on a networked digital video system and associating this image data with the pertinent data from the boarding pass(es) issued in the process. This data might be limited (if required) but be linked to the boarding pass or ticket data:

- passenger name;
- boarding pass ID;
- checked bag IDs;
- number of checked bags;
- airline name;
- flight date;
- flight number;
- departure time; and
- destination.

Most of this data is already printed on the boarding pass along with a bar code for machine reading equipment for the boarding passes.

What should be attempted is to have the airline reservation database forward the required data on a security file output mode, thus limiting potential access by competitors to the sensitive airline passenger profile and demographics data. By having the airline reservation system forward a packet of data on the checked-in passenger, the ASDF database would not be required to query the various airline reservation systems and the potential for competitors obtaining restricted data would be minimized.

4.3.4.3 Checked Baggage Screening

Checked baggage data input into the ASDF database may consist of the following data:

- baggage ID from Optical Tag or RF tag;
- X-ray image of baggage;
- X-ray Alert (detection of prohibited items); or
- Trace Vapour/Trace Particle results.

This data would be correlated with the passenger check-in data. They could then be retrieved together to enhance the security process. The output from the ASDF System could also be used by an automated baggage handling system or baggage handling personnel to determine the suitability of the baggage being boarded onto the flight.

This data could contain the status of the baggage under investigation. If there is a question about the passenger because of questionable data on the BEDS system, the ASDF System could be queried for additional data if available.

4.3.4.4 Passenger Screening

At the passenger screening checkpoint, the gathering of passenger related security data could also be implemented. With enhanced interfaces to the carry-on baggage screening X-ray machines implemented in hardware and connected to the LAN in the airport, these images could be digitized, transmitted, and stored in the ASDF database. It is also recommended that video monitoring be installed at each walk-through metal detector gate to record and send the passenger image data to the airport security system database. All of this data could be linked by scanning or reading the passenger boarding pass and scanning or reading the checked baggage ID tag.

At this passenger security interface the following data could be acquired for use in the ASDF System:

- passenger boarding pass ID;
- passenger ID;
- passenger image;
- passenger screening status;
- carry-on baggage X-ray image;
- carry-on baggage ID from optical tag or RF tag
- carry-on baggage content status;
- ticket ID; and/or
- trace vapour/trace particle results.

The ASDF System would be able to feed back to the passenger screening supervisor and alert status data on passengers whose checked baggage has been retained for further investigation or in response to passenger profile determination.

4.3.4.5 Boarding Gate Screening

The boarding gate equipment is generally in place for most larger airports with regular scheduled service by major airlines. This equipment, generally a reservations system terminal, a boarding pass printer, and an automated boarding pass reader (if installed), is already interfaced to the airline ticket reservation database and often to the airline departure control system. These terminals would not require any modification or change in software to interface to an external airport security system. It would require that the airline reservation systems send notification to the airport security system that a passenger has boarded the flight and has departed the air terminal.

The boarding gate security functions could be added and this security point could provide the following data to the ASDF database:

- passenger boarding pass ID;
- passenger ID;
- passenger video image; and
- ticket ID.

4.3.4.6 Master Control

The master control and associated monitoring station(s) would consist of the hardware and software necessary to control the ASDF System components. This functional centre would receive and evaluate the input data received from the various systems at the airport. This function could result in alarm conditions being flagged to the operator(s) with the display of this data from the database.

The major subsystems in master control would be a server, operating system software, database software, functions, storage/archiving software, graphical user interface software, and various expert systems software modules (in the future). Critical to the data fusion/integration work will be linking and time stamping data files.

Linking Data Files

Linking of all the various pieces of data acquired throughout the airport to a person, a ticket number, or a boarding pass number would be required. Once this link has been established, the ASDF System would be able to retrieve and process the various pieces of information to develop a more complete view of the check-in process and the activity of passengers as they board their flights.

The implementation of the ASDF System would offer an opportunity to enhance the security of passengers and airlines by recording the passenger check-in process on a networked digital video system and associating this image data with the pertinent data from the boarding pass(es) issued in the process. This data could be limited (if required) and could be linked to the following data:

- boarding pass ID;
- passenger name;
- number of checked bags;
- checked baggage IDs;
- carry-on baggage ID;
- passport number;
- airline name;
- flight date;
- flight number;
- departure time; and
- destination.

Most of this data is already printed on the boarding pass along with a bar code for machine reading equipment for the boarding passes. The most critical aspect of this system design would be the acquisition of this data from the airline reservation databases. If this link could be established, the ASDF System could be implemented, a full view of the security risks of the passengers determined, and appropriate actions taken to enhance the airport and airline system security.

Additional data associated with passengers, such as the passenger profile data, could be sent by the Computer Aided Passenger Screening System (CAPS). The passenger risk evaluation data available from some US airline databases could be used to enhance the security of the passengers in airports and on airlines. This CAPS data might consist of:

- passenger's appearance and behaviour;
- air ticket purchase data;
- passenger prior travel patterns;
- passenger routing to current location;
- airport location;
- flight destination;
- passport and documentation;
- travelling companions; and
- baggage.

Time Stamping Data

To assist in the analysis of events at the airport, the acquired data and the received data files should be time stamped from a reference system clock. This common time element could be used in post-event analysis to link various other events that initially may not have been considered related. In such situations, the common thread will be the time of data acquisition. In addition, this time stamped data could be used to observe events before or after the event of interest, which may have had significance.

Time stamping the data could help resolve delays that may have occurred because airline staff delayed scanning or entering the passenger data into the system database. In such situations, the associated data could be retrieved and corrections to the database made to enhance the security observations.

Once the hardware systems are in place, the master control system could be enhanced with other functions to improve security performance. These functions could be:

- computer-based image recognition;
- automated threat-detection functions; and
- other data fusion expert systems as sensor technology improves over time.

4.3.4.7 Local Area Network

The communications backbone of the ASDF System would be the Local Area Network (LAN). This should be distributed into several switched segment sub nets if the video-enabled functions are implemented. The Video Capture Devices would require about 128 to 320 Kbit/s data communications bandwidth per unit. This data rate and the number of units on the LAN should determine the segmented configuration of the system. Each of these segments should be linked through switched routers so that all network devices could route data to the ASDF System server.

The routers would use a 100Mbit/s link between themselves so no system bottleneck occurs to prevent data from being recorded. In some configurations, data should be transmitted to the database at near real-time rates. This mode of operation is required for video-enabled devices and security interfaces where passenger data is being acquired. For other applications, such as image-enabling the various X-ray systems, the picture data could be delayed as long as necessary, limited only by the temporary storage capacity of the interface unit.

In summary, the LAN would be operating at standard 10Mbit/s data rates for small systems and for small segments of the network. In the larger systems, the segments would be operating at 10Mbit/s and the backbone links would operate at 100Mbit/s rates. This configuration would minimize network delays and permit the system capacity to carry peak system loading data.

4.3.4.8 Wide Area Network

The Wide Area Network (WAN) would be implemented as receive-only datalinks from external agencies and organizations. This configuration would be the least security risk for receiving data and pertinent warnings about situations that may develop based on intelligence and other sources. These links and the access to the ASDF database system would generally be restricted, to minimize access to passenger data by competitors.

The data interfaces to external agencies should be firewall protected against intruders and unauthorized access. This interface would allow one-way data from external agencies into the ASDF System database.

These agencies would be linked into the ASDF System through a firewall using a defined data format and protocol. It may even be wise to consider using trusted communications links with encrypted data formats to transfer this data into the ASDF System. The bulk of the communication and data flow would be from the airline reservation system databases into the ASDF database. This data would be in an agreed-to format.

4.3.4.9 External Agencies

External agencies could be connected to the ASDF database through the WAN interface. In general, there would be very little requirement for this interface to be bi-directional in actual use. The data flow would in most cases be into the ASDF database.

The links to these other external agencies would be for special situations predefined in the operation of the ASDF System. When an incident has occurred either at the airport or in an aircraft, this data should be made available to external agencies. In such events, a data dump could be made of the incident(s) of interest and the database could be sent physically or electronically to the destination agency for evidence or investigation assistance. In many cases, the data can be gathered on some back-up medium such as CD-ROM or DVD-ROM for permanent and unalterable copies to be used in investigations and for legal proceedings.

The agencies that may have an interest and a need to be connected would be the following:

- airline reservation databases;
- customs brokers & shippers;
- airport security;
- other ASDF Systems;
- law Enforcement Agencies
  - RCMP;
  - FBI;
  - DEA;
  - CSIS.
- airline regulatory agencies
  - Transport Canada;
  - FAA;
  - NTSB;
  - FBI.
- immigration departments
  - Immigration Canada;
  - INS (USA).

4.4 Prototype ASDF System Implementation Options

4.4.1 Introduction

A prototype ASDF System could be implemented using current computer communications and video processing technology. The technology available today has not been previously considered in improving airport security for passengers or for potentially speeding passenger throughput without major system redesign. The concepts discussed in these design options could be implemented without creating additional passenger throughput delays or increasing workloads on staff already in place.

This technology, if implemented, could enhance passenger security, potentially lower security costs, and definitely improve overall security system performance. Unrelated data gathered at various parts of the airport systems could be gathered electronically and linked using the current data available in the system now, such as:

- ticket counter;
- check-in counter;
- checked baggage handling system;
- passenger screening; and
- passenger boarding gates.

Once the data has been gathered, the data fusion programs could evaluate the available data and make an informed evaluation of the security risk created by specific passenger(s).

4.4.2 Full-Scale Option

4.4.2.1 General

The conceptual full-scale ASDF System design would consist of the following components:

Custom Interface Units for:

- passenger walk-through metal detectors;
- carry-on baggage X-ray scanners;
- checked baggage X-ray scanners;
- boarding gate computer terminals; and
- trace particle and/or trace vapour chemical detectors.

Video Capture Devices at:

- ticket counters;
- ticket kiosks;
- check-in counters;
- passenger walk-through metal detectors;
- checked baggage X-ray scanners; and
- carry-on baggage X-ray scanners.

Boarding Pass Readers/Scanners at:

- passenger walk-through metal detectors;
- boarding gates;
- in the carry-on baggage X-ray scanner; and
- on the checked baggage X-ray scanner.

Interfaces to link ASDF to the airline reservation database(s) to be developed.

Secure database software to be developed.

Operating system (OS) software and related modules, i.e. GUI, to be developed.

A universal date transfer protocol to be developed.

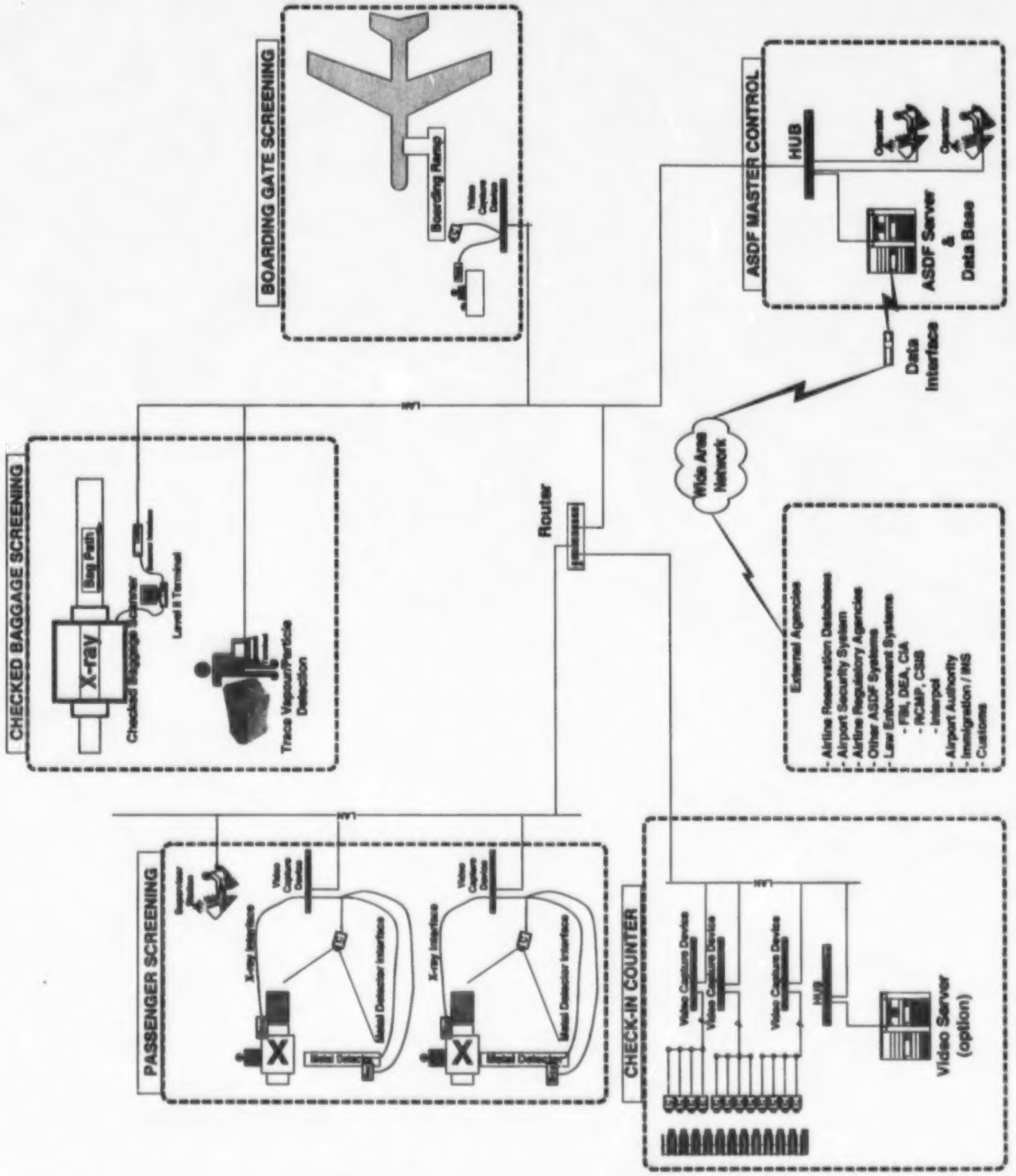

Figure 11 Full-Scale ASDF System Physical Architecture Diagram

Interconnecting these custom interface units, boarding pass reader/scanners, and video capture devices would be by a standard LAN system. This LAN would link these devices to the ASDF master control system server and computer system. This configuration would permit the gathering of passenger data, passenger identity, passenger baggage, and passenger behaviour data throughout the check-in and boarding process.

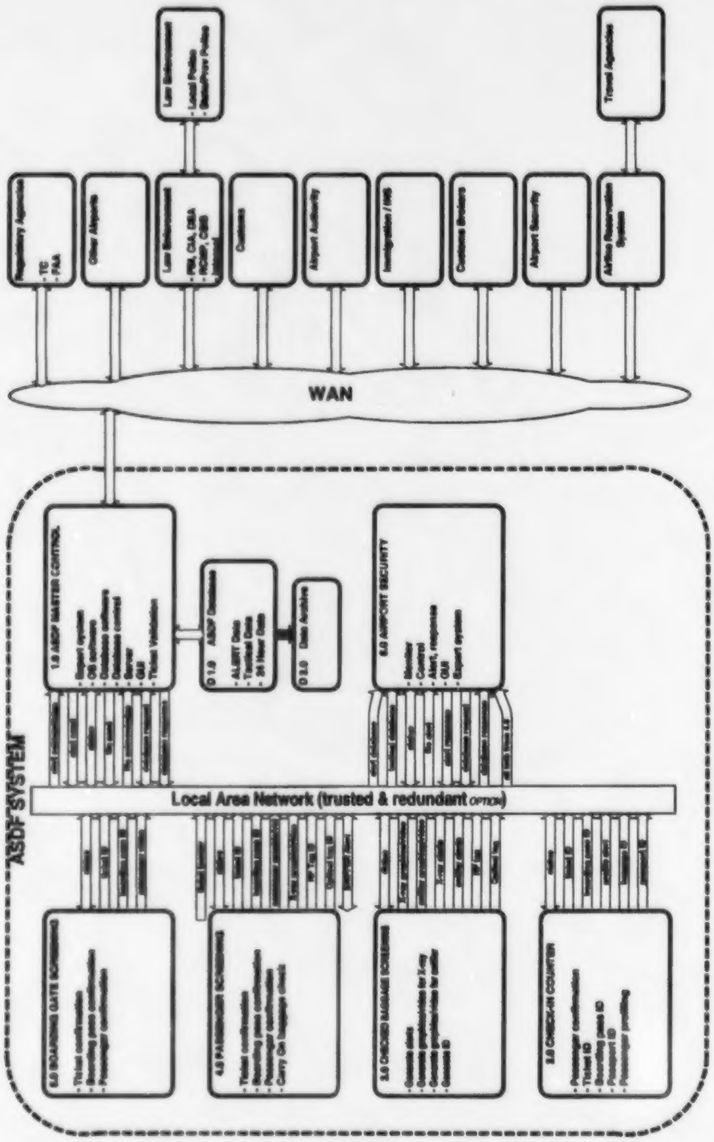

Figure 12 Full-Scale ASDF System Functional Block Diagram

4.4.2.2 System Issues

4.4.2.2.1 Redundancy

In the proposed ASDF system configuration, an element of redundancy is built in. The data being acquired and the evaluations of this data would not depend on receipt of ALL the data. In the data fusion processes, a level of security risk could be determined even if all available data has not been looked at. In this system proposed, the data from some interfaces may not be available for a variety of reasons, such as:

- ID tag misread;
- lost ID tag;
- communications system failure;
- inspection hardware failure;
- deliberate avoidance by passenger;
- manual procedures;
- operational requirements; and
- special events.

Some data may be lost and the ASDF System would still be able to determine a level of risk. In partial data situations, the number of alert situations may rise, but this could be handled by ASDF System operators or the security system supervisors at the points where the risk determination could be verified.

A benefit of the ASDF System implementation would be that almost all the various security screening processes could be monitored by supervisors for level of operation and developing situations, such as:

- passenger bottlenecks;
- increased line-ups;
- hardware failures;
- inspection hardware failure;
- operator failures; and
- system deficiencies.

All these situations could be monitored without causing any disruption to the ASDF System operation.

4.4.2.2.2 Future Enhancements

Future enhancements to the ASDF System could be implemented without having to redesign and modify the installed computer platforms, LAN network, or ASDF System interfaces. New technologies being developed could be added without great cost or extensive engineering change requirements. The functions that could be added are:

- face recognition processes;
- security control functions;
- access control and verification functions;
- event recording – digitally stored and retrieved;
- guard post functions during quiet periods; and
- aircraft access monitoring

These enhancements would not adversely affect the LAN system or the external WAN connections and performance.

Future system enhancements and increased functionality should be considered in the design, development, and implementation of a full-function demonstration ASDF System.

4.4.2.3 Full-Scale Work Breakdown Structure

The following Work Breakdown Structure (WBS) illustrates the high-level elements required to implement the full-scale option.

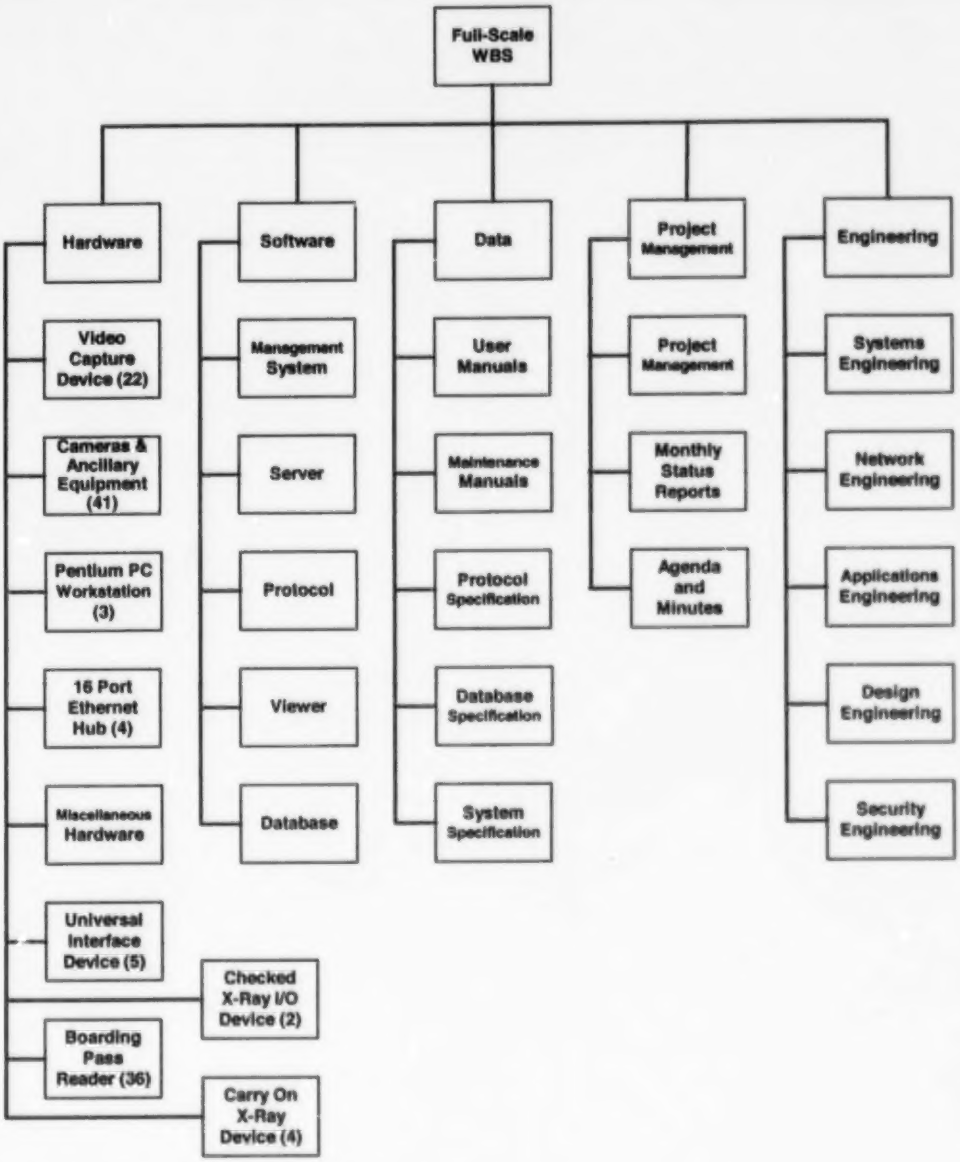

Figure 13 Full-Scale ASDF System Work Breakdown Structure

4.4.3 Reduced-Scale Option

The conceptual reduced-scale ASDF System design would be very similar to the full-scale system, with the exception of the checked baggage scanner interfaces. Such a system could consist of the following components:

Custom Interface Units for:

- passenger walk-through metal detectors;
- carry-on baggage X-ray scanners; and
- boarding gate computer terminals.

Video Capture Devices at:

- check-in counters;
- passenger walk-through metal detectors; and
- carry-on baggage X-ray scanners.

Boarding Pass Readers/Scanners at:

- passenger walk-through metal detectors;
- boarding gates; and
- in the carry-on baggage X-ray scanner.

Interfaces to link ASDF to the airline reservation database(s) to be developed.

Off-the-shelf (OTS) software would be used to demonstrate the system concepts in a non-secure, laboratory environment. The reduced-scale option is not intended for deployment.

Interconnecting all these custom interface units, boarding pass reader/scanners, and video capture devices would be by a standard LAN system configuration. This LAN would link these devices to the ASDF master control system server and computer system. This configuration would permit the gathering of passenger data, passenger identity, passenger baggage, and passenger behaviour data throughout the check-in and boarding process.

The reduced-scale functional ASDF System configuration is shown in Figure 14 below.

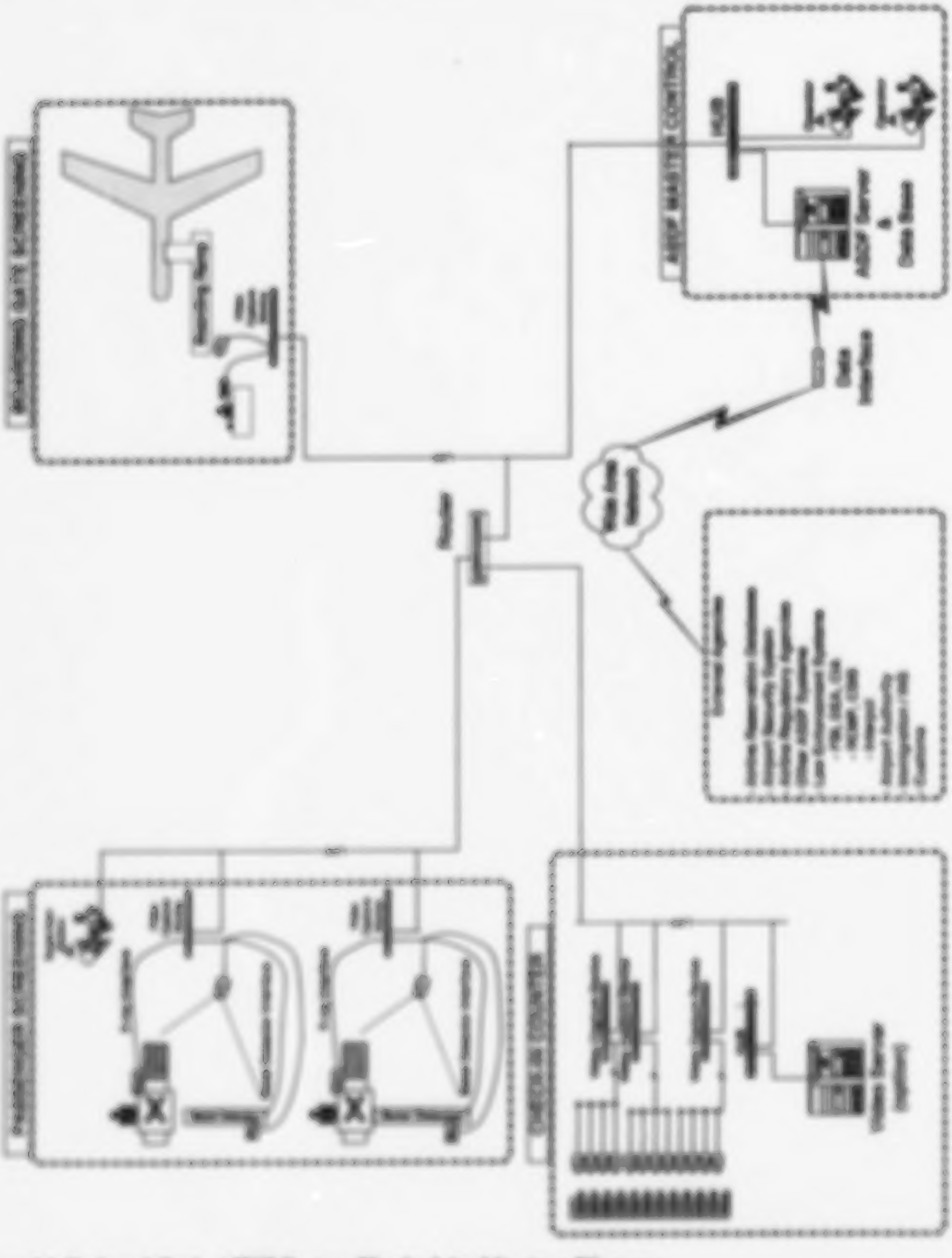

Figure 14 Reduced-Scale ASDF System Physical Architecture Diagram

The functional architecture concept for the reduced-scale ASDF System will appear as shown in Figure 15 below.

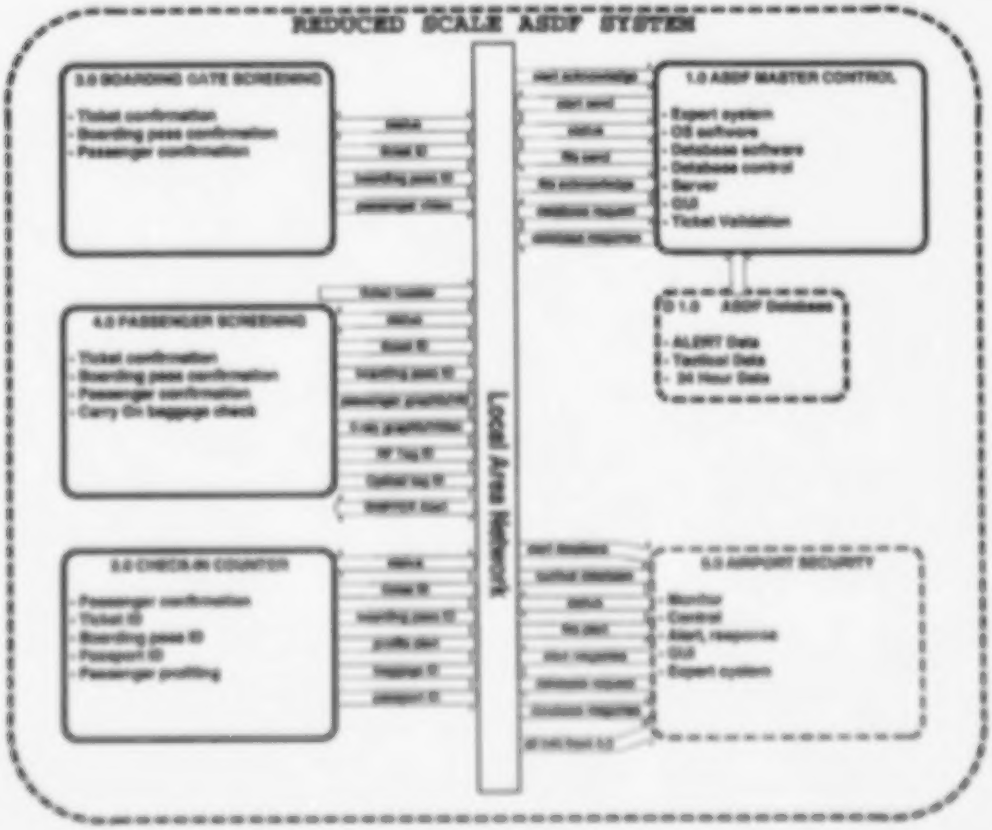

Figure 15 Reduced-Scale ASDF System Functional Block Diagram

4.4.3.1 Reduced-Scale Work Breakdown Option

The following Work Breakdown Structure (WBS) illustrates all the elements required to implement the reduced-scale option.

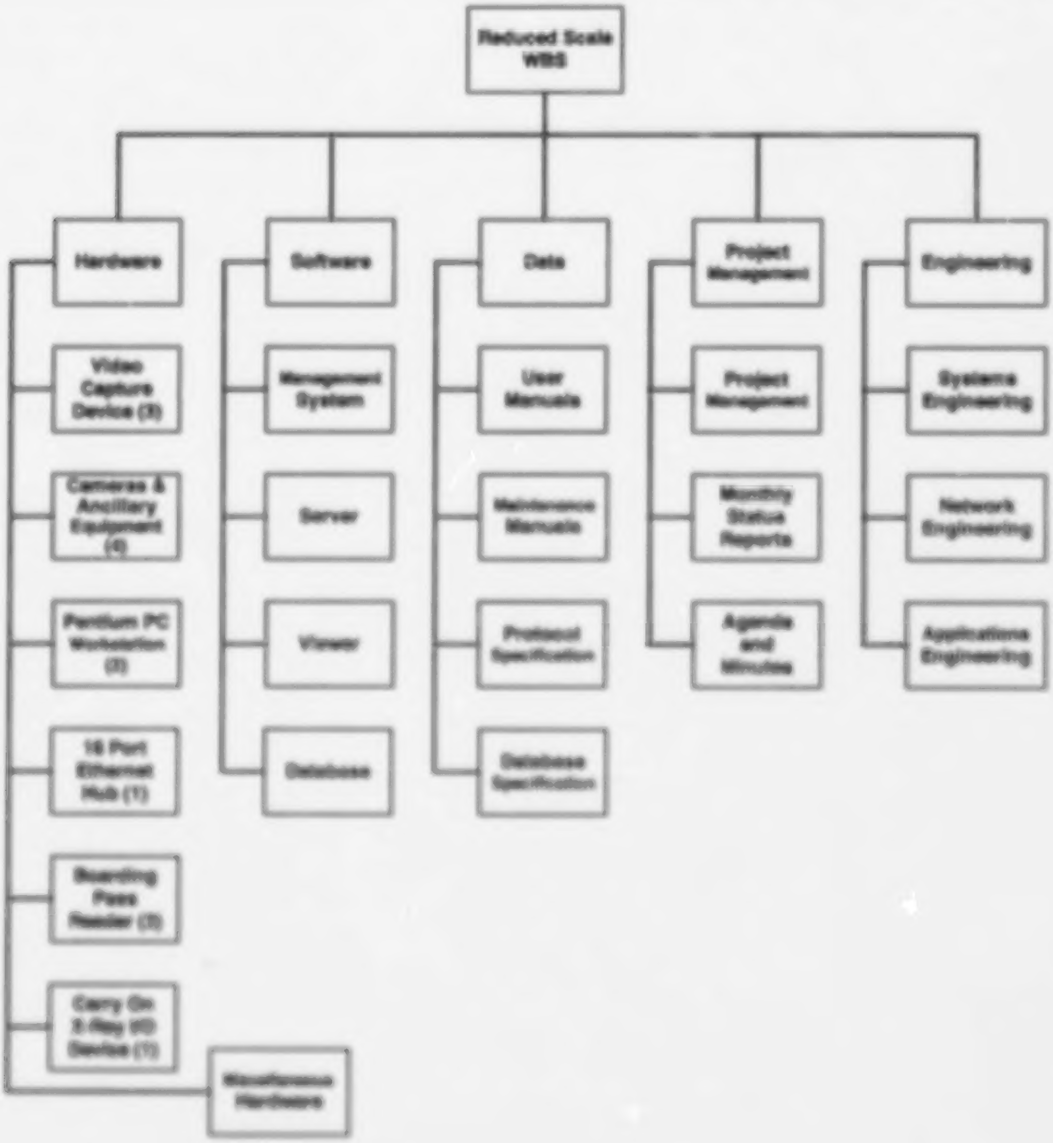

Figure 16 Reduced-Scale ASDF System Work Breakdown Structure

4.5 Graphical User Interface Concepts

Figure 17 illustrates the Graphical User Interface (GUI) coscept for the ASDF System. The GUI design assumes a minimum 19" monitor (a 21" monitor would be preferred) for the master control operator. It is also assumed that the screen has a 1024x768 minimum resolution. A brief description of the purpose of each screen follows.

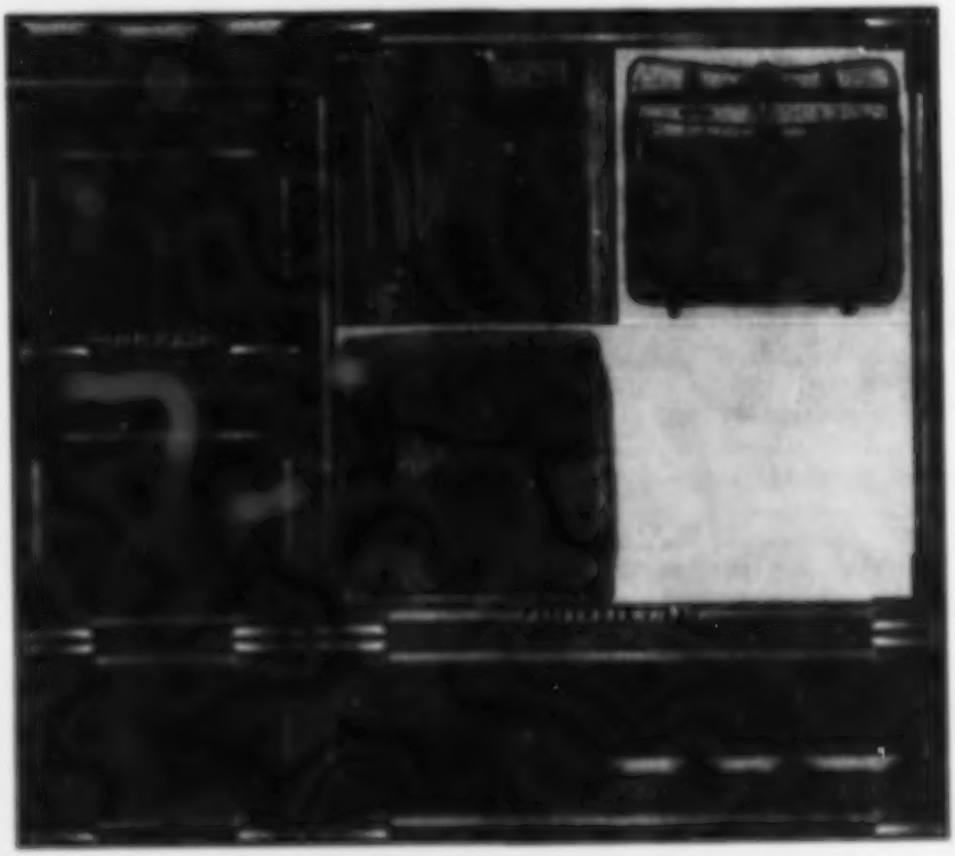

Figure 17 GUI Configuration for ASDF System

4.5.1 Overview and Summary of GUI Design Principles

The ASDF System Graphical User Interface (GUI) shouldbe designed for commercial level users who, it is assumed, would have a basic but not extensive technical proficiency with computers and database applications. It is also assumed that the viewer software would not be in constant use and that users would want to understand clearly and immediately the status of the ASDF System when they do interact with it. It is not expected that the user would have to remember complex procedures for operating the interface.

For these reasons it is proposed that the interface design b highly explicit in its layout and presentation. Important things should be bigger and, often, labelled. Vry important things, such as alarm notifications, should be animated and obvious colours used, to draw usrs' attention to a situation requiring their intervention.

The primary tools for interacting with the GUI should be clearly laid out and feature large buttons with both graphic and textual cues as to their purpose.

The ASDF viewer is to be designed to handle three key modes, alert status viewing of a file or files associated with real-time input of data, tactical status monitoring of related data files on a real-time basis by selected criteria, and 24-hour monitoring playback of the past 24 hours of data files for "off-line" viewing of events that have occurred during a given time period with specific event criteria. Thus this GUI would support three types of windows:

- **Alert Status Monitoring** – the main alert status window used to show the status and data of tagged files for operator intervention.
- **Tactical Status Monitoring** – the tactical status window used to observe the status and data for selected criteria such as the flight, the passengers, or the association with passengers, etc.
- **24-Hour Monitoring** – the window used to browse, search and playback historical data files associated with alert files or other selected data and files.

Multiple instances of both the alert and 24-hour monitoring historical files in a window could exist at any one time (this could be achieved by double-clicking the application shortcut again, or by choosing the Window/New… menu).

The design will allow the user to switch easily from one mode to another. It will also allow users to easily manage multiple ASDF files without penalizing the (assumed) majority cases that have only one ASDF database viewer installed.

4.5.2 GUI Design Criteria

4.5.2.1 General

GUI design rules/guidelines[9] for the ASDF System for the main control computer system should consider the following assumptions/issues:

- Inexperienced users often do not understand metaphors.
- ASDF System users are not IT experts and cannot intuitively know what was intended.
- The same object should not appear multiple times.
- Rules on when an item should appear in a leaf versus when it should appear in a detailed list should be clearly defined.
- Long scrolling lists of objects should be avoided.
- A clear and obvious hierarchy of data should be presented.
- Users do not use the ASDF System continuously.

4.5.2.2 GUI Design Guidelines

Ideally the GUI design should be developed for clarity and ease of use, avoiding visual clutter. For designing the appearance and operation of the GUI, these guidelines may be used:

- Group boxes should organize a set of controls on a window, rather than being used as field labels.
- Mnemonics (keyboard shortcuts) should be associated with fields contained in the group box, not the group box itself.
- Labels should be bolded when combined with grey backgrounds, with white space between the labels and the text fields.

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[9] Classic System Solutions, Inc. Design Forum. Some design concept criteria and suggestions retrieved from GUI Design Tips Web site at http://www.classicsys.com/html/guiguide.htm.

- Icons should not be placed on default tabs of property sheets, unless the property sheets are complex. In such cases, the tabs should be redesigned to fit just the data and the icon on each one.
- Two sizes of icons, 16x16 and 32x32, should be created and registered for all primary windows so that icons will remain recognizable in all applications.
- Tool tips, if any, should describe very briefly the function of the control.
- More detailed help should be displayed on the application message bar.
- The ellipsis symbol (…) should only be used to show that more parameters are required to complete the action, not to indicate another window to be opened.
- Mnemonics, which are invoked with an "Alt" key, should be displayed on menu items.
- Accelerators should be displayed after menu items (accelerators span multiple drop-down menus and are invoked with the "Ctrl" key modifier).
- Information that is either temporarily unavailable or displayed as read-only for users to select, read, or copy should be displayed in a normal text control box with an inset border. The colour should be the same as the window's background.
- Static text (text used for field labels and descriptive information in a window) should appear on a window without a border.

4.5.3 Proposed ASDF System Main Window

The main window for the GUI would be the Alert Status Monitoring window. This is the window that the data fusion engine and database data would flag for questionable or trapped security files and events. This is the database view that would need a response by the ASDF System operator for further action (or none).

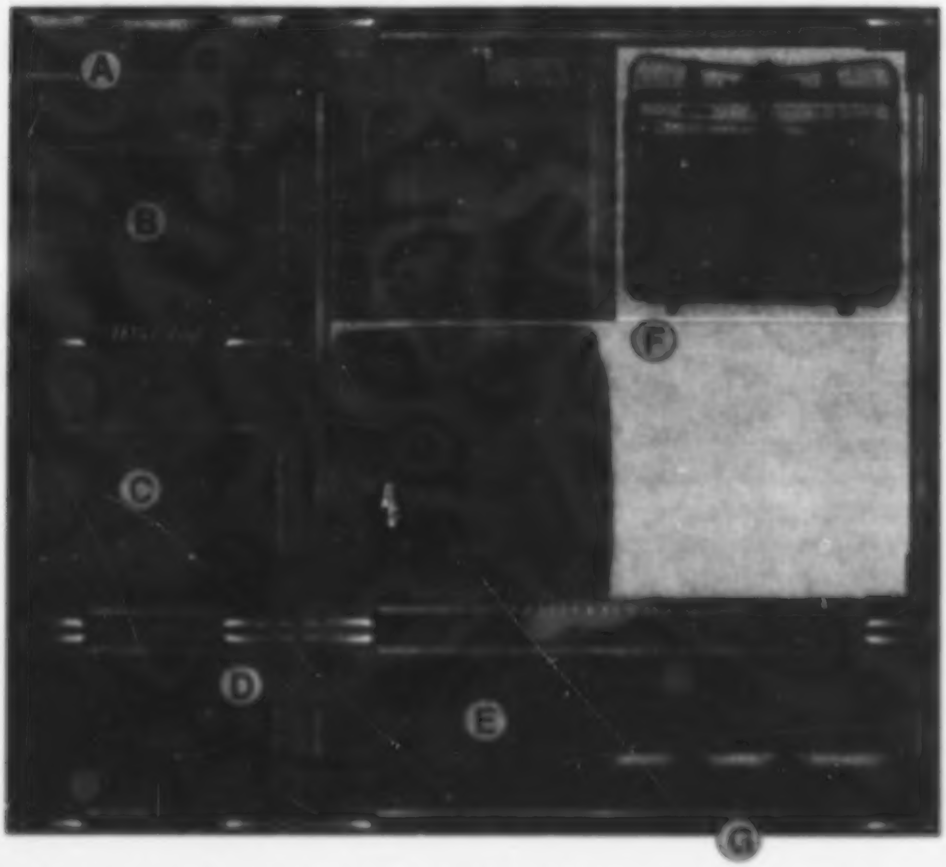

Figure 18 The Main User Interface Components in Display Mode

The following legend identifies the main GUI components for the proposed ASDF System interface.

A – Main Menu Selection – ALERT Status Screens
– TACTICAL Status Screens
– 24 HOUR HISTORICAL Playback Screens
B – Video or other sensor information window
C – Command window for interfaces to ASDF system
D – Alert and Alert Status window
E – Urgent status and Alarm Annotation window
F – Image Data of file under review
G – Command and Action Acknowledge buttons

4.5.3.1 Alert Status Monitoring

The Alert Status Monitoring Screen displays the current passenger files that have associated alerts and require operator action. This screen is the default screen for general system operation. This is the primary user screen.

Data viewing can be performed in single full screen views or quad image mode. In either mode, the operator can view data by many various arrangements.

Quad mode allows users to display up to four video images simultaneously. The individual video displays are articulated via adjustable separator bars. Within each section is a border that will indicate "active camera" by its colouring (i.e. blue for active and background colour for non-active).

The currently active video image source is indicated via the video/image selector buttons on the toolbar.

4.5.3.2 Tactical Status Monitoring

The tactical status monitoring screen will display user-defined data for any passenger or flight that has yet to reach its destination airport.

At a pre-determined time, the passenger files associated with a particular flight are archived to the 24-hour portion of the ASDF System database.

4.5.3.3 24-Hour Monitoring

This viewer is similar to the tactical viewer, except that it is capable of viewing data that is up to 24-hours old. Beyond the 24-hour time frame, the ASDF System data is archived to a storage medium that is not readily accessible by the user.

4.6 Network Interface Specification Concepts

Network interface specifications need to be defined in several areas and at varying levels of software function. These interface design specifications need to follow the standard industry practices so that hardware interfaces, networks configurations, and software drivers and functions can be used without the need for custom hardware and software.

These standards have been designed and implemented in various configurations for almost all computer and communications systems in use today.

This proposed standard for the airport security systems and equipment interfaces will need to define the following functions as defined by the ISO 7 Layer Reference Model (or ***ISO Reference Model of Open Systems Interconnection***). In this approach all of the required data and protocol functions can be defined and referred to common approaches and definitions.

Layer	Functionality
7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link (Hardware Inerface)
1	Physical Hardware Connection

Figure 19 The ISO 7 Layer Reference Model for Open System Interconnection

- *Physical Layer.* This layer specifies a standard for the physical interconnection between host computers and network packet switches, as well as the procedures used to transfer packets from one machine to another. In the reference model, Level 1 specifies the physical interconnection including electrical characteristics of voltage and current.

- *Data Link Layer.* The Level 2 portion of the X.25 protocol specifies how data travels between a host and the packet switch to which it connects. X.25 uses the term *frame* to refer to a unit of data as it passes between a host and a packet switch. Because raw hardware delivers only a stream of bits, the Level 2 protocol must define the format of frames and specify how the two machines recognize frame boundaries. Because transmission errors can destroy data, the Level 2 protocol includes error detection (i.e., a frame checksum). Finally, because transmission is unreliable, the Level 2 protocol specifies an exchange of acknowledgements that allows the two machines to know when a frame has been transferred successfully.

  One commonly used Level 2 protocol, named the *High Level Data Link Communication*, is best known by its acronym, *HDLC*. Several versions of HDLC exist, with the most recent known as *HDLC/LAPB*. It is important to remember that successful transfer at Level 2 means a frame has been passed to the network packet switch for delivery; it does not guarantee that the packet switch accepted the packet or was able to route it.

- *Network Layer.* The ISO reference model specifies that the third level contains functionality that completes the definition of the interaction between host and network. Called the *network* or *communication subnet* layer, this level defines the basic unit of transfer across the network and includes the concepts of destination addressing and routing. Thus, the network might allow packets defined by Level 3 protocols to be larger than the size of frames that can be transferred at Level 2. The Level 3 software assembles a packet in the form the network expects and uses Level 2 to transfer it (possibly in pieces) to the packet switch. Level 3 must also respond to network congestion problems.

- *Transport Layer.* Level 4 provides end-to-end reliability by having the destination host communicate with the source host. The idea here is that even though lower layers of protocols provide reliable checks at each transfer, the end-to-end layer double checks to make sure that no machine in the middle failed.

- *Session Layer.* Higher levels of the ISO model describe how protocol software can be organized to handle all the functionality needed by application programs. The ISO committee considered the problem of remote terminal access so fundamental that they assigned layer 5 to handle it. In fact, the central service offered by early public data networks consisted of terminal-to-host interconnection. The carrier provides a special purpose host computer called a *Packet Assembler And Disassembler (PAD)* on the network with dialup access.

- *Presentation Layer.* ISO layer 6 is intended to include functions that many appiication programs need when using the network. Typical examples include standard routines that compress text or convert graphics images into bit streams for transmission across a network. For example, an ISO standard known as *Abstract Syntax Notation I (ASN.1)*, provides a representation of data that application programs use. One of the TCP/IP protocols, SNMP, also uses ASNA to represent data.

- *Application Layer.* Finally, ISO layer 7 includes application programs that use the network. Examples include electronic mail or file transfer programs.

For this recommendation, it is proposed that the message format just below the application be the highest level that needs to be defined in the ISO 7 Layer Reference Model [10] as illustrated in Figure 20.

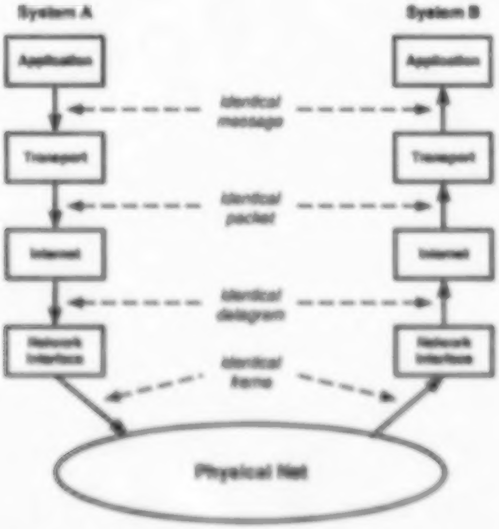

Figure 20 The Path of a Message From Application A to Application B

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[10] This data extracted from "Internetworking with TCP/IP Volume 1 Principles, Protocols, and Architecture" by Douglas E. Comer, Department of Computer Sciences Purdue University, West Lafayette, IN 47907. ISBN 0-13-216987-8 (v.1), Published 1995.

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5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study examined various existing and soon to be deployed airport security equipment types and systems. Data was acquired from most of the manufacturers of this equipment, as well as technical manuals and documents about this equipment's interfaces and its interaction with external controls or systems. In addition, other sources were used to obtain data not readily available from the manufacturers' technical manuals, such as the manufacturer's web sites, FAA reports, ICAO documents, IATA documents, and government (USA and Canada) documents available publicly. All of the systems and equipment investigated are listed. The data so obtained in this report has been described in text form and pictures in Appendix D and has been tabulated in Excel spreadsheets in Appendix E.

The study found that every piece of equipment used for security applications has interfaces that can be accessed to retrieve video/picture data or to detect an alarm condition for the security database application.

Each portion of the airport security system functions independently of the others. Using a common security database, it would be possible to link them all together in a way that permits an increased level of protection.

A way to connect all airport security equipment and systems to a single central airport security system database must be developed. This process must include development of a universal interface unit or units that can accept data from the security equipment, without having to modify the existing equipment. The development of such an interface unit is possible. It should interface to the security equipment at the lowest common level of interface used by most of the systems. This level of interface could be at the following levels:

- Video VGA or SVGA interface;
- Ethernet 10BaseT (10 Megabits data rate);
- Ethernet 100BaseT (100 Megabits data rate);
- RS-232; and
- Contact closures.

Each interface would require a custom or semi-custom box to adapt the data interface (physical, electrical, and logical) to a standard output data transmission interface, most likely 10baseT or 100 Megabit Ethernet, and present the data in a standard format so that the airport security system can assimilate it.

Generally, air carriers are very sensitive to processes imposed by regulators and the related costs of implementation. Any system implemented must be inexpensive and significantly better at detecting threats, and should leverage existing investments in infrastructure.

5.2 System Overview

5.2.1 Ticket Terminals

The ticket reservation terminals are all interfaced to the airline reservation database through the local LAN, a regional WAN, or a dial-in connection. These terminals enter and retrieve the data for the reservation system and would not require any modification or change in software to interface to an external airport security system database.

5.2.2 Check-In Counter Equipment

The existing data entry equipment at the check-in counters is:

- Ticket/check-in counter terminals
- Boarding pass printer
- Checked baggage tag printer

All this equipment is interfaced to the airline reservation database through the local LAN or the regional WAN connections. These terminals enter and retrieve the data for the reservation system and would not require any modification or change in software to interface to an airport security system database.

5.2.3 Passenger Screening Equipment

The existing passenger screening equipment consists of:

- Metal detectors
- Carry-on baggage X-ray scanner
- Hand wand metal detector

5.2.3.1 Carry-On Baggage X-ray Scanner

This X-ray scanning equipment has multiple configurations and various types of interfaces for retrieving the scanned images of checked baggage processed. In this equipment the interface between the video image and the airport security system database should be a custom designed unit that can accept one of the many different signal formats for the data. This interface box would convert either:

- VGA/SVGA video to digital format
- Ethernet interface data
- Custom interface data

Once the X-ray image data has been captured and converted into a standard format suitable for saving as a record in the airport security system database, the data could be transmitted over a LAN to the database system for storage and reconciliation with other data.

5.2.3.2 Walk-Through Metal Detector

The walk-through metal detectors in use at airports have a non-standard interface that needs to be adapted to the airport security system database. In this application, a relatively simple contact closure for metal detection would be sufficient to trigger a video signal capture of the passenger triggering the alarm.

It would be wise to capture the image data (if available) of the traveller passing through the metal detector gate and recording this data in the airport security system database for future reference.

5.2.3.3 Hand-Held Metal Detector

Passengers who have triggered the walk-through metal detector alarm are checked in greater detail by individual security personnel to confirm that there is no prohibited item on their person. This alarm condition has already been detected and since there is no readily available interface on this device, it is not required to be connected to an airport system security database.

5.2.4 Checked Baggage Screening Security Equipment

The checked baggage screening equipment has the largest variety of interfaces. Every piece of equipment that has been investigated has a different interface, either physically or at the transport layer. Even variations of the same equipment from the same manufacturer have interfaces that differ dramatically. Almost all X-ray systems have no inherent function for storing X-ray images and for downloading them from the system.

In the systems that have external terminals that need to access the X-ray images, the data (logical) interfaces are all non-standard. The physical interface may be standard, such as:

- 10BaseT (10 Mbit/s Ethernet using UTP cable)
- 100BaseT (100 Mbit/s Ethernet using UPT cable)
- FDDI communications (nominally 100 Mbit/s)
- Fibre optic physical media
- Copper cable physical media

In systems that use modems or remote access terminals, especially the trace vapour and trace particle testing systems, the data interfaces tend to be low speed. These systems use interfaces such as:

- RS-232
- Parallel printer ports
- Dial up modems

In all cases, these systems would require custom interface boxes and systems to permit the readout of the image or other testing results for presentation to the airport security system database. This part of the airport security system will require the most hardware, software, and systems engineering to implement data integration/fusion capabilities.

5.2.5 Boarding Gate Screening Equipment

The boarding gate equipment generally consists of a reservations system terminal, a boarding pass printer, and an automated boarding pass reader (if installed). This equipment is already interfaced to the airline ticket reservation database through the local LAN and the external WAN networks to the airline reservation system and (in some cases) the airline local departure control system. These terminals would not require any modification or changes in software to interface to an external airport security system.

5.3 Recommendations

The study found that every piece of equipment used for security applications has interfaces that can be accessed to retrieve video/picture data or to detect an alarm condition for the security database application.

This study found that no single, convenient interface exists on any of the screening security equipment or systems that can communicate to other systems from other manufacturers. Each manufacturer of airport security equipment has a different way to communicate to their systems. Even different systems from the same manufacturer cannot communicate to each other or to some common control system and permit the exchange of data.

Nevertheless, this feasibility study has shown that most of the airport security equipment and systems could be linked to an airport security system database. This could be accomplished by designing and developing interface units that can adapt the available data interfaces, data protocols, and data formats to a single common system level interface, without affecting the operation or functions of the systems already deployed. Once these interfaces have been developed for the airport security equipment and systems, such as baggage X-ray scanners, passenger screening equipment, airline reservation terminals, and boarding gate terminals, the data from many of these systems could be used to enhance the level of security at airports.

The three recommendations from this feasibility study are as follows.

5.3.1 Recommendation 1

It is recommended that any new checked baggage equipment, carry-on baggage X-ray screening equipment, and passenger screening equipment be specified to have an interface available for data and image output. This interface should be able to work in several modes of data I/O to a common digital data format and to a physical LAN interface. It should be defined for both the physical and the data structure and protocol formats. This standard, when developed and implemented, would permit a central database to query or receive broadcast mode data from these systems and the server would then be able to determine what needs to be done with this data.

The development of this interface and protocol standard would permit all future checked baggage X-ray machines and carry-on X-ray machines to transfer image data to a central database for applications such as ASDF or other related functions. Passenger scanning equipment would be able to transmit the results of a scan to a central ASDF database without further processing. This capability, if implemented, would create an open system architecture for communications and permit various manufacturers to transfer data to third party equipment and systems.

This proposed standard should be defined following the ISO 7 Layer Reference Model (or ***ISO Reference Model of Open Systems Interconnection***). In this approach all of the required data and protocol functions can be defined and referred to common approaches and definitions.

This recommendation, if implemented, would permit future systems integration to be implemented without extensive requirements for interface hardware and custom modules that may need to be retrofitted.

5.3.2 Recommendation 2

It is recommended that video imaging be added to the following locations:

- Passenger check-in counter
- Passenger screening points
- Aircraft boarding gates

At each of the above listed security points video monitoring and recording should be added so that the behaviour and identity of a passenger could be confirmed and linked to other security data. With digital video imaging and recording of the person(s) checking in, clearing passenger screening, and boarding the aircraft, the identity of this person(s) could be determined and confirmed by either real-time processing or by post-event analysis.

5.3.3 Recommendation 3

It is recommended that a small-scale version of a full-featured airport security system database application be limited initially to:

- Passenger check-in counter
- Passenger screening points
- Aircraft boarding gates

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(2) limited baggage match;
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(4) fingerprint and background checks; and
(5) special cargo procedures.)

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APPENDIX B – THE TECHNOLOGY

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THE TECHNOLOGY

Introduction

Specific screening technology is not normally identified in the guidelines that have been reviewed. International guidelines are concerned with the completeness and rigor of the screening of passengers and their associated baggage, and leave the choice of technology to the local authorities.

Some discussion regarding the completeness of the searches is made but the figures are inconsistent and the guidelines do not normally address specific performance figures. They do, however, repeatedly mention the need to reduce or minimize flight delays and passenger inconvenience.

Mention of technology is normally restricted to technology in common usage including:

- passenger screening
  Screening technologies involve either walk-through or hand-held metal detectors.
- carry-on baggage screening
  Screening technologies discuss X-ray technology.
- checked baggage screening
  Screening technologies discuss X-ray technology.
  In this technology, signal processing is used to enhance detection probabilities.
  Screening technologies also discuss Trace Vapour and Trace Particle technologies.

Additional technologies, such as trace/vapour and trace/particle detection, are discussed. There have been some steps taken, however, to further the use of such a technology through international agreements on the introduction of trace elements into explosives during manufacture.

The search for Checked Baggage Screening (BEDS) equipment technology was based on interviews with specialists and research literature from:

- the FAA;
- Canadian MOT specialists;
- US Congress reports;
- ICAO documents; and
- product information.

The search for trace vapour and trace particle technology was based on:

- interviews with specialists;
- research into the literature; and
- product information.

Security experts in Canada, the USA, and Europe were interviewed to establish the significant technological attributes that could be used to categorize each product. The interviews with these experts were conducted either face-to-face, over the phone, or via fax, as the opportunity presented itself. The attributes included sampling time, sensitivity, accuracy, cost, portability, and size.

A review of security literature was performed to identify trends and significant issues, and prospective vendors were polled to collect product data and specification sheets. The resulting information was reviewed, and product interface capabilities quantified according to the identified important attributes.

An excellent report on the technology used for explosives detection in checked baggage is the US Government report, "***Technology Against Terrorism: The Federal Effort***; July 1991, OTA-ISC-487; NTIS order #PB91-219998; GPO stock #052-003-01246-4". This document [1]can be found on the FAA Web site as file "9139 OTA-ISC-487.pdf". It clearly explains the various techniques and approaches available to detect prohibited devices and material in checked baggage.

Explosives Detection

One of the most important types of detector is the explosives detector. It is of great utility, not only for airline security but also for the protection of fixed facilities, such as embassies, nuclear plants, or other sensitive buildings.

Some detectors (e.g., detectors utilizing X-rays, gamma rays, or neutrons) employ ionizing radiation to measure the object's properties. Radiation is used to penetrate the object and the detector measures the outgoing radiation that contains detailed information about the contents of the items being scanned. This type of detector is limited in that, although it can be used on baggage, it cannot be applied to people. They would be injured by the harmful effects of ionizing radiation at the intensities required by the widely available techniques. Recent progress in imaging objects, using "microdoses" of X-rays, is under assessment and could be applied to humans. However, even if it could be rigorously shown that human exposure to microdose X-ray equipment would have negligible health effects, there would still be a severe problem in overcoming public scepticism toward the use of this type of equipment.

Another type of bulk detector uses non-ionizing electromagnetic (EM) radiation in the form of radio waves. This technology includes high resolution, millimetre wave radar that can search baggage or clothing for objects (such as explosives) that would scatter the microwaves. Also included in this design group are nuclear magnetic resonance (NMR) and nuclear quadrupole resonance (NQR) spectrometers. These devices expose the volume to be searched to a pulsed radio frequency EM field and then "listen" for pulse echoes that are characteristic of particular explosive compounds. Such detectors might be useful for consensual searches of persons for concealed explosives, if the EM fields employed are sufficiently weak.

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[1] U.S. Congress, Office of Technology Assessment, Technology Against Terrorism: The Federal Effort; July 1991, OTA-ISC-487; NTIS order #PB91-219998; GPO stock #052-003-01246-4" [This document can be found as file "9139 OTA-ISC-487.pdf"].

X-ray Technologies

Existing commercial X-ray scanners are capable of giving high-resolution images of the interior of objects. They have been used for many years to check hand-carried baggage and, more recently, checked baggage[2]. During the last five years, major strides have been made in X-ray technology. New models offer significantly greater capabilities than those in general use at airports today. Some of these new systems can now differentiate between materials composed of light or heavy elements, and some offer very good resolution with three-dimensional imaging capability. In general, X-ray systems are under development by established, large or mid-sized commercial manufacturers and these systems represent modifications to their current products. Consequently, new X-ray systems can be brought to market much more rapidly than most of the other devices under development.

The most important new developments in X-ray systems are in the areas of:

- Dual or multi-energy systems;
- Backscatter X-rays; and
- Computed X-ray tomography (CT).

Dual or multi-energy systems can distinguish between low and high Zeff (or effective atomic number) elements to a degree and can present the viewer with two or more images that emphasize the different materials by, for example, colour differentiation.

Commercial devices with this capability are produced by:

- EG&G Astrophysics;
- Vivid Technologies;
- InVision Technology Inc.;
- L3 Communications Inc.; and
- Siemens-Heimann.

Backscatter X-ray

A somewhat different approach to explosive material detection (EDS) in checked baggage is represented by the backscatter X-ray system, developed by American Science & Engineering (AS&E). In this case, the low Zeff (or effective atomic number) image is created by a process of detection of Compton backscatter radiation. Commercial Z-Scan systems exist, and the manufacturer is now attempting to develop an automated pattern recognition approach that will meet the FAA's EDS requirements. Discrimination between high and low Z, although useful, does not specifically and uniquely identify explosives.

This backscattered X-ray imaging technique is used to measure energy that is scattered due to the Compton effect. Although some radiation penetrates the baggage in a straight path and is measured by the transmission detector, some of the X-ray energy is scattered either forward through the scanned object, or backwards towards the X-ray source. The images obtained by measuring scattered energy are called the forward scatter and back scatter images.

The AS&E Model 101 series of MICRO-DOSE™ Inspection Systems uses AS&E's patented "flying spot" X-ray scan technology (shown in Figure B-1). Radiation generated by an X-ray tube is collimated by combining a long stationary slit and a rotating wheel with four slits to produce a pencil-size X-ray beam. This X-ray beam rapidly scans a parcel as it moves through on a conveyor. X-rays that collide with the parcel are absorbed by the parcel, scattered off the parcel, or transmitted through the parcel. For the Model

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[2] U.S. Congress, Office of Technology Assessment, **Technology Against Terrorism: The Federal Effort**; July 1991, OTA-ISC-487; NTIS order #PB91-219998; GPO stock #052-003-01246-4" [This document can be found as file "9139 OTA-ISC-487.pdf"].

101Z system, two detector systems generate images for display, one detector system for the transmitted image and the second detector system for the backscattered image. The detector signals are sampled, digitized, and stored in digital display processors for display on two high-resolution 15-inch video monitors.

The AS&E developed system uses three detector systems for image generation: one transmission image detector and two backscatter image detectors to scan both sides of the parcel during one pass through the X-ray beam. The backscatter monitor's split-screen displays backscatter images from both sides of a parcel simultaneously.

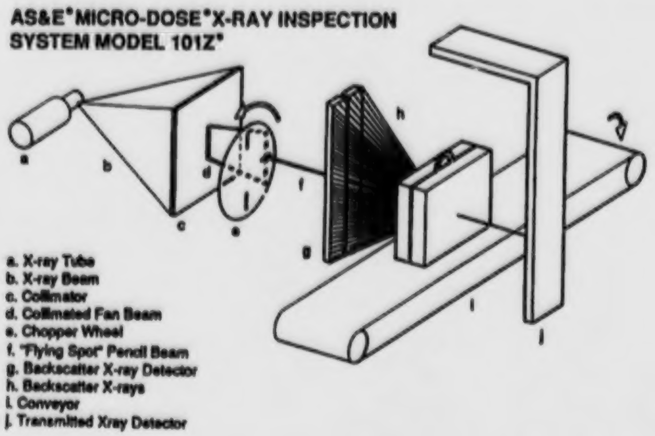
AS&E® MICRO-DOSE® X-RAY INSPECTION SYSTEM MODEL 101Z®
a
b
c
d
e
f
g
h
i
j
a. X-ray Tube
b. X-ray Beam
c. Collimator
d. Collimated Fan Beam
e. Chopper Wheel
f. "Flying Spot" Pencil Beam
g. Backscatter X-ray Detector
h. Backscatter X-rays
i. Conveyor
j. Transmitted Xray Detector

Figure B-1 Simplified Diagram of Backscatter X-ray Scanning System

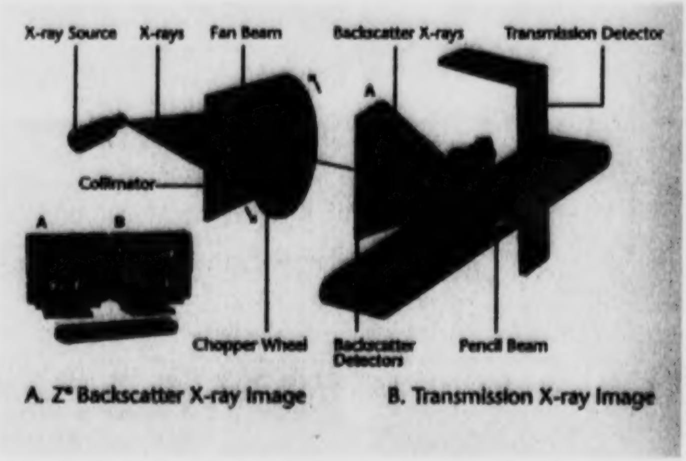

Figure B-2 Z Backscatter X-ray Imaging Concept

Dual Energy X-ray

Early security systems used high energy X-ray for the detection of weapons. At higher energy levels (over 100 KV), the absorbed energy depends primarily on the density of the material: the higher the density, the more energy is absorbed by the object, therefore the darker the image. A metal object, such as a weapon, or an explosive device, both dense materials, would appear very dark in the transmission image and would be detected. However, an explosive device could be concealed behind a denser material, making it invisible to the system operator.

To resolve this problem, baggage is scanned at two energy levels. At lower energies (usually 80 KV), the absorption depends mainly on the effective atomic number (Zeff), as well as the thickness of the material. Using multi-energy transmission images, high density and low Zeff explosives can be identified. Figure B-3 illustrates the density and effective atomic number of materials of interest in baggage inspection systems. A system that uses two X-ray energy levels for scanning is called a dual-energy system. Several techniques exist for the collection of multi-energy images, including varying the input energy of the X-ray source, filtering the energy at the X-ray sensor and using multiple sensors with different spectral responses.

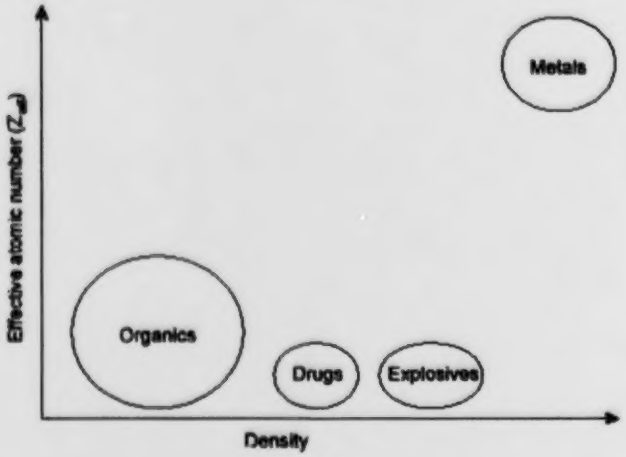

Figure B-3 Zeff versus Density of Selected Materials

When dual energy X-ray beams are used to scan checked baggage, the systems are able to detect and characterize the contents of the bag. The pictures in Figure B-4 show the results of dual energy X-ray beam technology coupled with extensive data processing computer systems.

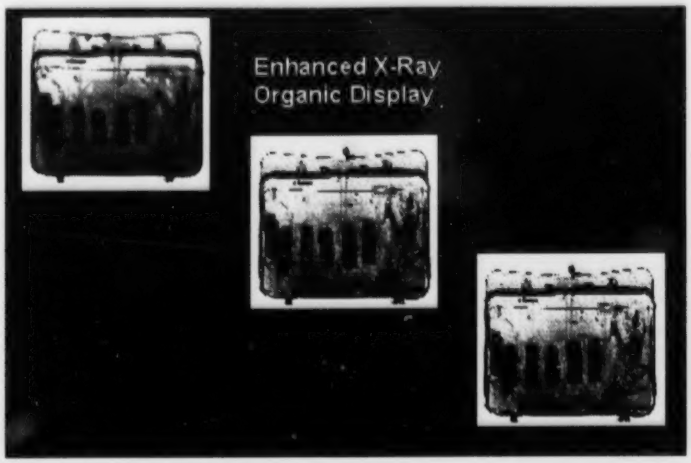

Figure B-4 Dual Energy X-ray System Picture Capability

Computed Tomography (CT)

The word tomography is derived from the Greek **tomos**, meaning slice or section, and **graphein**, meaning to write or record. CT creates cross section images by projecting a thin-beam X-ray through one plane of an object from many different angles. As the X-rays pass through the object, some radiation is absorbed, some is scattered, and some is transmitted. In some scanners a cone-beam covers an area detector so that many slices, or a volume, can be scanned at once.

The radiation transmitted through the object at each angle is measured and referred to as attenuation data. It is a measure of the reduction in X-ray intensity that results from absorption and scattering by the object.

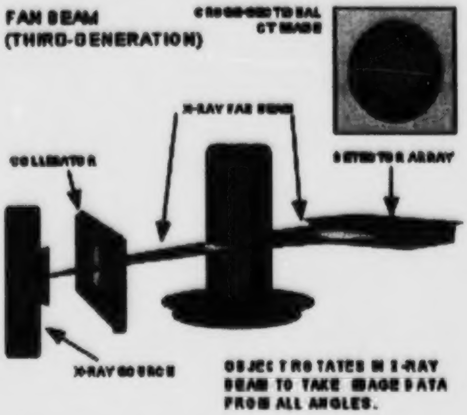

Figure B-5 Stylized Diagram of CT X-ray Scanner

In CT scanning, the attenuation data is summed over the many different angles from which it was collected using a computer in a method called reconstruction. Reconstruction essentially "builds" the CT image from the data collected and represents a cross-section of the object.

CT scanners typically consist of four hardware subsystems: a radiation source, a radiation detector system, a mechanical manipulator, and a computer with display. The radiation detector system is composed of detection elements, such as scintillating crystals and photodiodes. A data acquisition system (DAS) measures radiation data transmitted through the object and digitizes it into a format that can be handled by the scanner's computer system.

A mechanical manipulator is needed to precisely move the object relative to the X-ray source and detector system. Finally, a CT system requires a computer to control the scan motion and the timing of data acquisition. The computer then also reconstructs the image from raw data.

CT SCANNING

As computed tomography technology developed, researchers created improved methods of collecting the X-ray projections through an object. These methods, called generations, use different motions to collect the projections.

For first generation systems a single pencil beam of X-rays transverses linearly across an object. Once a traverse is completed, the object is rotated a small amount (typically 1 degree) and the transverse is repeated up to at least 180° of rotation.

For second generation systems, the number of detectors was increased to encompass a small fan of X-rays so that it covered the whole width of the object under investigation. In this system, each detector array sees its own parallel set of rays. Because of the transverse motion of the object through the beam, the scans can be completed in less time and a more detailed image is built up of the contents.

In the third generation CT scanners currently coming into use or under advanced product development, both the X-ray tube and the multi-detector array rotate around the object. Each detector thus covers a different annulus, rather than the whole object. In checked baggage application, the bag moves through the rotating X-ray beam on the conveyor. With no transverse motion, scans can be done in a few seconds. However, the beam must span the entire width of the object, increasing detection costs. Since data is not in parallel beams, complex reconstruction algorithms are used to build the image from this raw data. This technology permits the scanning and viewing of the item under investigation from many (almost any) angles and thus the detection of hidden or partially hidden prohibited material.

Combining the CT scanning with the dual energy X-ray beam technology, it is now highly likely that prohibited items and material can be effectively detected in checked baggage. This technology is dependent on high speed data acquisition and processing computer systems to detect and display the contents of baggage.

Trace Vapour Detection by Chemical Means

The vapour detector, or "sniffer," is a different class of detector[3]. In this type of device, air samples are taken and examined by rapid chemical analysis techniques for the presence of molecules of explosive compounds. This class of detectors can be used to search people as well as baggage.

The original vapour-based explosives detector is, of course, the dog. Dogs are very effective for some purposes but there are some serious "canine factors" limitations. Although dogs are very sensitive detectors:

- they have limited attention spans;
- to be most effective, they should be integrated into a team with a particular trainer, thereby generating high operating costs; and
- on a day-to-day basis, they may be inconsistent.

While dogs are still the best explosives detectors available for a wide variety of applications (e.g., to sweep a well-defined area in the wake of a bomb threat, dogs are not appropriate choices for many other purposes, including routine baggage inspection on airlines.

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[3] Most of this section has been copied verbatim out of U.S. Congress, Office of Technology Assessment, **Technology Against Terrorism: The Federal Effort**; July 1991, (pages 47 – 50).; OTA-ISC-487; NTIS order #PB91-219998; GPO stock #052-003-01246-4" [This document can be found as file "9139 OTA-ISC-487.pdf"].

Man-made vapour detectors perform three general tasks:

- first, they collect a sufficiently-large sample of molecules;
- second, they remove interfering materials and impurities or concentrate the sample or both; and
- finally, they test the remaining material in a way that generates a unique response to the presence of explosive compounds.

The extremely low vapour pressure of many of the materials to be detected makes the first step – the collection of an adequately large sample of molecules – a serious challenge (see Figure B-6). Ethylene Glycol Dinitrate (EGDN) has the highest vapour pressure of the common explosives and is present, in a saturated volume of room temperature air, at the relatively high concentration of 1 part per 10,000. Chemically, EGDN is similar to the antifreeze commonly used in automobiles, – differing only in that it contains two nitro (NO_3) groups. Like its antifreeze cousin, bulk quantities of EGDN exposed to the air are easily detected by even that relatively insensitive detection device, the human nose.

A saturated vapour of DNT (dinitrotoluene, a common contaminant in TNT--trinitrotoluene) or nitroglycerine (NG) contains about one molecule of target compound per million molecules of diluent. Ammonium nitrate (AN) and TNT itself are present at a concentration of about 1 part in 100 million (10^8).

The plastic explosives RDX and PETN are even less volatile, being present in a saturated volume of air at standard temperature and pressure at a concentration of 1 part in one million million (or trillion -10^{12}). This concentration is comparable to:

- one shot glass of whiskey in Loch Ness;
- about 30 cents out of the US national debt; or
- one second out of 32,000 years.

Cyclotetra-methylene tetranitamine (HMX) is, by a factor of about 60, even less volatile.

The concentrations described herein represent saturation, a condition unlikely to be encountered in the field. Thus, in all likelihood, substantially less material than suggested here will be available for capture.

In addition to the vapour pressure of the pure compound, several factors affect the concentration of detectable vapour in the vicinity of an explosive. If a dynamite explosive device is contained within a more or less enclosed small volume, after an extended time (on the order of hours or days) the concentration of explosive molecules within the enclosed space will build up towards equilibrium conditions. Air from such a suitcase or drawer or other container would contain near the maximum possible number of molecules. If the nearly saturated air could then be released and sampled, the probability of detection would be enhanced. On the other hand, materials such as TNT, PETN, RDS, and HMX would adsorb so strongly into clothing and inner surfaces of suitcases that even, after a year, there would not be enough molecules to detect the explosive material from air samples taken from the interior of the suitcase.

Another factor is the presence or absence of relatively higher vapour pressure contaminants, which are often introduced or created during the manufacturing process. In many cases these contaminants will cause some of the detectors to alarm. The concentration of these contaminants in the air surrounding a sample of explosive is a function of their concentration on the surface of the piece. Thus, they are most easily detected around a freshly broken piece. As they evaporate from the surface, their concentration near the explosive's surface declines. Molecules of the contaminant will, over time, diffuse to the surface from within the bulk of the explosive but this is a relatively slow process. Therefore, while such contaminants can be a benefit to the detection process, their presence cannot be relied on.

Finally, the presence or absence of physical carriers will have a profound effect on the motility of explosives molecules. Many researchers now suspect that most sniffers often respond to explosive molecules attached to small carriers such as dust specks.

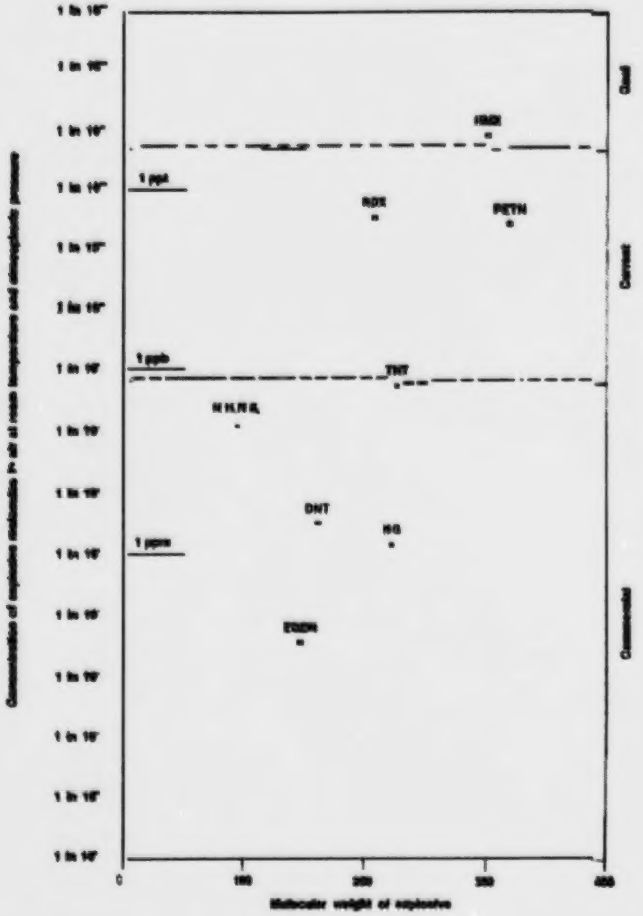

Figure B-6 Relative Volatility of Some Common Explosives

The relatively high electronegativity of these explosive compounds is a mixed blessing. It causes the molecules to be "sticky," rather in the way that static electricity makes balloons cling to a wall. This electronegativity is helpful for detection in that it makes the explosive compounds rather unique among organic molecules in their ability to attract and retain electrons, thereby forming negatively charged species (anions). The formation of anions is used by several detection schemes in testing for the presence of explosive in a sample. But this same property also causes difficulties for detection because the molecules bind to surfaces so strongly that shaking them loose in order to sweep them into a detector is not easy. Further, this affinity of the molecules for surfaces further depletes their concentration in the air sample. These twin effects form both the basis and the bane of many devices used to increase the concentration and number of molecules at the detector part of a sniffer.

The first stage of a sniffer will usually sample the incoming air by drawing it over a surface onto which the sticky explosive molecules attach themselves. In this manner, the molecules contained in a large volume of air may be captured. Later, on heating the surface, the molecules are driven off. By performing this heating step in a stream of gas of much smaller volume than the originally sampled air stream, the concentration of the explosive molecules is enhanced.

The thermal instability of these compounds is a problem. The aggressive efforts (heating) sometimes needed to separate a sample of the explosive material from a substrate substance so that it may be channelled to a detector, can cause the compound to degrade into smaller fragments that go unrecognized by the detection equipment.

On the other hand, some detection techniques actually depend on a related property, the frangibility (fragmentation) of these compounds. On impact with the proper targets (70 eV electrons or atoms of an inert gas, for example), these molecules will fragment. Under the right conditions, the kind and number of fragments into which the explosive molecules break down is predictable. In this manner, the presence of an explosive compound in the tested vapour may be confirmed. The two-stage mass-spectrometry device takes advantage of this property.

The capture of a sufficiently large number of molecules of the explosive compounds probably constitutes the most difficult step for the sniffers. The explosive compounds do not shed many molecules into the air on account of their low volatility, and, consequently, successful vapour detectors must be sensitive to the presence of pico or even femto gram quantities of material (10^{-12} and 10^{-15} gram respectively). The performance of vapour detectors can also be degraded by the presence of interfering materials and impurities, which can both trigger false alarms and lower the sensitivity of the equipment to real explosives. Finally, the effectiveness of the system is dependent on matching the detection strategy to the properties of the specific explosive compound present.

In the United States until very recently, tests conducted on sniffers did not yield very favourable results. In March 1988, the FBI examined the performance of four commercially available explosives vapour detectors under realistic conditions. While most of the instruments could easily and reliably detect pure samples of the higher vapour pressure materials (EGDN and NG) under laboratory conditions, results in real world scenarios, including searches of suitcases and cars, were disappointing. The authors concluded:

> ***"The challenge still remains to find a small hand-held detector able to reliably detect inorganic and plastic-based explosives in operational scenarios." (1991)***

Vapour detection schemes do have certain advantages. They seem to be more amenable to automation because the typical output of the machine is a fairly simple electronic signal that can be satisfactorily interpreted by a microprocessor. No complicated pattern recognition is involved. Further, by generally avoiding the use of large radioactive sources and their attendant public relations problems, shipping and exporting these machines is a simpler matter. For the same reason, unlike detectors using large amounts of ionizing radiation, they can be used to screen radiation-sensitive subjects, such as humans. Also, because they generally do not require any shielding, they can be smaller and more portable and thereby more versatile than bulk detectors. For example, they are available as hand-held units that can be carried around a test object by a single person. Finally, techniques are being developed to compensate for the low volatility of the explosive compounds. For example, some experts have had success using a swab to wipe down a suspected person or object, then testing the swab for residues. These detectors are being used in a variety of search scenarios.

Trace Particle Detection by Chemical Means

Trace particle detection is a different technology than trace vapour detection. Trace particle detection technology is used to detect minute amounts of physical explosive chemical residue in the form of particles found on or in the surfaces of the items under test.

Trace-particle detection technologies require the physical collection of samples of explosive chemical residue material from containers, clothing, or bodies of individuals, and these samples are used to infer the presence of dangerous materials. Physical samples are collected using swipe swabs by physically touching them to people or their baggage to remove particles of explosive residue from them or their belongings.

Until a few years ago the focus of sniffer technology was on the detection of nitroglycerine-based explosives, and, in particular, the most volatile component of those explosives, ethylene glycol dinitrate (EGDN)[4]. Not only is EGDN readily detectable in commercial dynamite, it is often present as an impurity in many military and other nondynamite explosives, serving as a convenient vapour marker for these products[5]. However in the 1980s, while dynamite production declined, plastic explosives became more widely accessible, and, because they could be shaped and disguised to evade visual and X-ray inspection, surfaced as the material of choice for terrorist activity. At the same time, it was evident that the detection of plastic explosives by sniffer devices or trained canines, on the basis of characteristic vapour emission, was problematic at best. Consequently in an effort to counter the threat posed to civil aviation by plastic explosives, an international resolve was formulated through ICAO to tag such products with minor quantities of volatile substances during manufacture, for the purpose of enhancing their detection by available gas-sampling equipment.

Concurrent with the ICAO initiative, an alternative approach to the detection of plastic explosives has also been under development. This approach is based on the rationale that in the act of secreting plastic explosives, an explosives handler may inadvertently transfer telltale traces of the explosives to the exterior surfaces of the package or baggage used. These traces generally prevail in the form of microparticles or oily stains, and require sampling techniques different from those applicable to the detection of airborne vapour traces.

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[4] Elias Lorne, Journal of Testing and Evaluation, Volume 22, Number 3, May 1994, Development of Trace Explosive Detection Standards p 280.

[5] Linenberg, A., *Proceedings of New Concepts Symposium and Workshop,* Reston, VA, October 1978, p. 269, sponsored by U.S. Depts. of Treasury, Energy, Justice and Transportation.

ICAO Convention on Marking Explosives

The ICAO has implemented a convention for the making of plastic explosives with a detection taggant for easier detection of this material in security applications. The ICAO "Convention on the Marking of Plastic Explosives for the Purpose of Detection", was drawn up and signed at Montreal, on 1 March 1991 (Montreal Convention 1991). To date this convention has been signed by 51 states (as of June 1998) and 38 nations have ratified this convention.

A detection agent is any one of those substances set out in the following Table B-1. Detection agents described in this Table are intended to be used to enhance the detectability of explosives by vapour detection means. In each case, the introduction of a detection agent into an explosive will be done in such a manner as to achieve homogeneous distribution in the finished product. The minimum concentration of a detection agent in the finished product at the time of manufacture should be as shown in the said Table B-1.

Table B-1 ICAO Convention Detection Agent

Name of detection agent	Molecular Formula	Molecular Weight	Minimum Concentration
Ethylene glycol dinitrate (EGDN)	$C_2H_4(NO_3)_2$	152	0.2% by mass
2,3-Dimethyl-2, 3-dinitrobutane (DMNB)	$C_6H_{12}(NO_2)_2$	176	0.1% by mass
Para-Mononitro-toluene (p-MNT)	$C_7H_7NO_2$	137	0.5% by mass
Ortho-Mononitro-toluene (o-MNT)	$C_7H_7NO_2$	137	0.5% by mass

---

Any explosive which, as a result of its normal formulation, contains any of the designated detection agents at or above the required minimum concentration level will be deemed to be marked.

OPINION: There are enough untagged explosives in the world today to last for the next 10 or 15 years for terrorist applications. In the long run, this convention will help in the vapour or trace particle detection of these explosive materials.

Metal Detector

The CEIA model 02PN10 Security Metal Detector is the workhorse and foundation upon which their metal detectors are based. It is characterized by having the electronics unit integrated into the gate or separate from it. The 02PN10 is a high performance detector for use at airports and other high security applications. It uses a unique system of variable magnetic field generation and receives signal analysis based on an innovative concept of recognition and exclusion of electrical interference. The uniformity of the field using this method allows clear-cut discrimination between compact masses of metal such as weapons and personal objects such as keys and coins. Concealed weapons can be intercepted in velocity ranges up to 15 metres per second without a variation in sensitivity. The archway, which is programmable with variable configuration to detect magnetic and/or non-magnetic metals, can be linked into data networks. Other features include the ability to absorb electrical and mechanical interference even when in close proximity to the metal detector, without losing any of its features of uniformity, sensitivity and discrimination.

The walk-through pulsed-field metal detectors do not work like most people think they do. Here is a list of observations:

1. The magnetic field is outside of the archway as well as inside; it behaves like a magnet.

2. The magnetic field is usually lower than the Earth's magnetic field, and therefore cannot erase magnetic tape.

3. A pulsed-field metal detector detects mostly the outside surface of a metal object. This means that the chamber and the bullets have little effect upon the sensitivity of the metal detector.

4. The "program" settings of a metal detector determine the **relative** sensitivity between different alloys and metals. This is done so that users can set the total sensitivity to a level where the metal detector is not overly sensitive to a particular alloy.

5. The FAA uses three guns of different alloys to test metal detectors: a stainless steel 22-caliber revolver, a 38-caliber aluminum derringer, and a mixed-alloy 25-caliber automatic. This is done to make sure that a metal detector is sensitive enough to detect all guns likely to be carried by individuals.

6. "Plastic" guns usually contain metal and can usually be detected.

7. Sensitivity to an object can vary according to the object's speed through the archway, the direction the object is pointing, and the location of the object in the archway.

8. Therefore, the sensitivity needs to be set to the level where the metal detector alarms at the weakest response to speed, direction, and location.

9. A computerized metal detector's performance may not be what was ordered, since the software can be changed to work differently. Software can also be made to "design to test", or be more sensitive when the computer recognizes a test is in progress, but not be as sensitive when normal conditions are recognized.

10. This way the metal detector can look good when tested, but have a lower alarm rate under regular use.

11. Walk-through metal detectors only work properly if the object is moving through the archway within a normal walking speed range. To test an object without carrying it, stand about 10 feet from the archway entrance and hold the object at arms' length.

Objects that are most likely to set off a walk-through metal detector are:

- Large moving objects just outside of the archway (like baggage).
- Large belt buckles.
- Shoes with steel toes.
- Shoes with steel arch shanks. (A surprising number of shoes have these.)
- Proximity access control cards. (They are designed to be easy to detect.)
- Badges or jewellery with large loops.
- Large key-chain rings.

Objects not likely to set off a walk-through metal detector:

- Surgical pins.
- Rings and small jewellery.
- Coins and pens.
- Credit cards.
- Small magnetized materials. (It makes no difference if something is magnetized.)
- Shoe nails.
- Moderate-sized watches. (Batteries have no special effect.)
- Cigarette or gum packs with foil.
- Cigarette lighters.
- Keys and eyeglasses.

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APPENDIX C – INTERVIEWS CONDUCTED

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The following list of people identifies specialists in the airport and aircraft security screening industry and agencies that were approached during the ASDF study. The interviews attempted to collect opinions on the future development of these technologies. Their opinions were also solicited on the appropriateness of the technology use in airport security screening in a civilian situation.

Barrette, Jean.

Director, Security Operations, Transport Canada, Ottawa, Ont.

As one of the driving forces behind this project, J. Barrette was not aware of any security system where the data was collected and then integrated or fused.

Beaudet, Beverly

Project officer at IATA.

B. Beaudet is presently trying to develop a system that will integrate information, concerning the identity of passengers, received from Customs, from Immigration, and from the airlines. This is a major problem for airlines as the carrier is held financially responsible if a person enters the country illegally via the air carrier. Certain jurisdictions (especially within the U.S.) also seize aircraft if a passenger is carrying prohibited materials (e.g., drugs) into the country. B. Beaudet is of the opinion that her project concerning the identification of passengers could dovetail very nicely with the initiative undertaken by Telexis on behalf of TDC.

Cartwright, Nick

Nick Cartwright is a Civilian Member of the RCMP Laboratory, specializing in Chemistry.

For several years, Mr. Cartwright has been assisting Transport Canada and ICAO with explosive detection methods and systems. He is presently seconded to Transport Canada on a special assignment in Security Operations and reports to Mr. J. Barrette. Although he does not know of any system presently in use which would be similar to the one being proposed, he is of the opinion that this would be an ideal tool for the decision-maker in determining the threat posed to an aircraft by a particular passenger. A more in-depth interview will be scheduled with Mr. Cartwright at a later date.

Littler, Mel

Director of Security, Manchester Airport, Manchester, U.K.

M. Littler was contacted because ITS had installed a system which incorporated video with some of the other components at the pre-board screening point. The system was evaluated for one year and found to be quite good. It could not be used at Manchester, however, because of the legislated requirements of U.K. law (e.g., the necessity to hand-search 20 percent of all passengers and 20 percent of all hand baggage).

Posluns Howard

H. Posluns is the main point of contact on this project at TDC and one of the driving forces on this initiative.

It is his view that developing a profile of the passenger to determine suitability is the basis of this study. Data fusion from all sources would help develop that profile.

Reese, John

J. Reese is an employee of the Federal Aviation Administration (FAA) and has been seconded to the ICAO in Montreal.

From J. Reese, we learned that ITS had developed some form of system that had been installed at Manchester Airport.

Sutherland, Roy

Chief, Security and Facilitation, ICAO, Montreal, Que.

R. Sutherland was not aware of any system similar to the one envisaged by this project. R. Sutherland made ICAO staff available for consultation.

Wall, Brian

Director of Security, International Air Transportation Association, Montreal, Que.

B. Wall is well travelled and has visited the major countries of the world. B. Wall is not aware of any system in place. He put us in touch with Beverly Beaudet of IATA who had some ideas about this project. B. Wall knows of biometrics being used to identify airport employees, but not passengers.

APPENDIX D – EQUIPMENT INFORMATION

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EQUIPMENT INFORMATION

Introduction

The various pieces of equipment listed in this section have been culled from the list originally given with the start of this study. This list of equipment covered all of the current systems being used by the Canadian or USA air transport systems to meet the ICAO requirements for provision of security in the air transport system. There are several pieces of equipment that have been derived from the list as more modern versions of the listed systems being used or planned for use in airports.

The order of description of the various systems is in the order being used at airports and follows the order given on the "Existing Airport Security Equipment" spreadsheet of machines and systems to investigate for data fusion applications.

Passenger Screening Equipment

Hand-Held Metal Detector

Garrett

Superscanner

The Garrett Superscanner is a portable, battery-operated, magnetic flux gate. This device generates a varying magnetic flux on the sensing end of the scanner and measures the decay of the field when it is turned off. If there is magnetic material in close proximity to the field, a variation will be detected in the field when it decays. This change in the decay of the magnetic field is what is used to sense metal objects:

- On a person; or
- Inside non-magnetic materials.

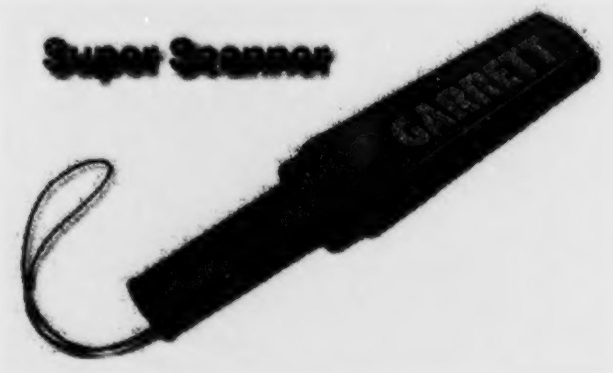


Figure D-1 Garret Superscanner

Interface

The Garrett Superscanner is a hand-held metal detector. The only interface that the Superscanner has is an acoustic jack. In normal operation, this device is manually operated by security personal at the security gates when a metal detector has indicated an alarm.

An acoustic relay could be tied-in to the acoustic jack for networking purposes.

Walk-Through Metal Detector

CEIA

02PN10 Security Metal Detector

The CEIA 02PN10 Security Metal Detector is a magnetic flux gate detector that measures changes in the electromagnetic field that it produces when a person with ferrous metal enters the field. In this system, there are three magnetic flux-sensing coils and the sensitivity can be adjusted to meet operational requirements.

Figure D-2 CEIA 02PN10 Security Metal Detector

Interface

The CEIA 02PN10 Security Metal Detector has four RS-232-C interface connectors. Some are optional.

These connectors are wired in parallel so that a group of Security Metal Detectors can be controlled and operated together from one controlling workstation. These four DB-9 connectors can be used to interconnect a group but, generally, only two connectors are used with:

- one interfacing to the previous unit or the control computer; and
- the other connecting to the next 02PN10 Security Metal Detector in the chain.

These RS-232 connections can:

- be used to program the metal detector; and
- be notified when an alarm condition has occurred.

The remote programming and monitoring is done with the ASCII command string from the control computer, running a communications program (such as ProComm Plus or equivalent) at a nominal 9600 baud rate at 8N1 data format. Optionally other rates can be selected. Programming can also be done directly on the 02PN10 Security Metal Detector through the keyboard.

The 02PN10 Security Metal Detector is also outfitted with:

- passenger interface LED's;
- a buzzer; and
- a control panel with LED bar graph display.

The RS-232C DB-9 interface has the following connections:

- pin 2 data in;
- pin 3 data out; and
- pin 5 ground.

Carry-On Baggage Screening Systems

Heimann Systems

Hi-Scan 6040-A

The Heimann Systems Hi-Scan 6040-A is an X-ray machine designed to inspect carry-on baggage and other small items. The Hi-Scan 6040-A has an X-ray tube that generates a fan-shaped beam that scans a slice of the baggage as it moves through the beam on the conveyor belt.

The image of the item under inspection is generated as the signals from the L-shaped detector array of 684 photo diodes are detected and processed. A new scan is taken for every 1 mm of physical motion of the item under inspection. Each scan (slice) of the item is processed and the results are presented on a colour or black and white display for viewing by the operator. This system is film-safe up to 1600 ASA.

Interface

The Heimann Systems Hi-Scan 6040-A is a carry-on baggage screening system. The 6040-A has:

- an RS-232 port with a DB-25 connection; and
- a VGA output.

Also available from Heimann is an optional box that will save the image presented to the screen to a connected computer in a common file format such as Bitmap (bmp).

The RS-232 port is for diagnostics only. It communicates at 9600 bps across a VT100 terminal with a data format of:

- 8 bits data;
- no parity; and
- 1 stop bit (8-N-1).

The DB-25 on the 6040-A is configured as follows:

- pin 3 transmit;
- pin 2 receive; and
- pin 7 ground.

The VGA output could also be captured so that the baggage scan results could be appended to the passenger profile.

Interface Hardware/Translation

The Heimann Systems Hi-Scan 6040-A carry-on baggage scanner has no direct data export interface. Heimann sells an interface unit called "PC STORE" as an option that needs to be installed into each X-ray unit. This optional interface unit can then retrieve, store, and transfer on command the stored X-ray images to a standard PC, over a network card such as 10/100 Ethernet. At the destination PC system, these images can be converted into standard format such as bitmap (bmp), JPEG (jpg), or TIFF (tif), using OTS LINK software.

Hi-Scan 6040i

The Heimann Systems Hi-Scan 6040i is similar to a Hi-Scan 6040-A, upgraded with additional interfaces. The Hi-Scan 6040i is an X-ray machine, designed to inspect carry-on baggage and other small items. The Hi-Scan 6040i has an X-ray tube that generates a fan-shaped beam that scans a slice of the baggage as it moves through the beam on the conveyor belt.

The image of the item under inspection is generated as the signals from the L-shaped detector array of 684 photo diodes are detected and processed. A new scan is taken for every 1 mm of physical motion of the item under inspection. Each scan (slice) of the item is processed and the results are presented on a colour or black and white display for viewing by the operator. This system is film-safe up to 1600 ASA.

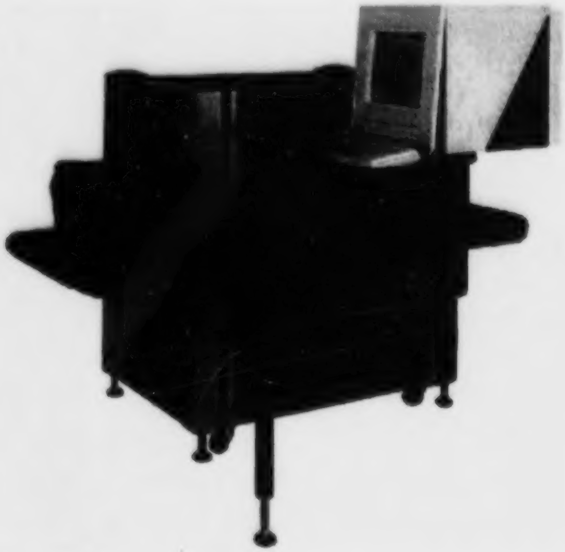


Figure D-3 Heimann Systems Hi-Scan 6040i

Interface

The Heimann Systems Hi-Scan 6040i is a carry-on baggage screening system. The 6040i is the same as the 6040-A, with an Ethernet port added (i.e., the HI-TRAX option). The 10baseT Ethernet port allows images to be retrieved by a remote system on the network. The images are encoded in a Heimann proprietary format. Conversion software is available from Heimann. The conversion software is capable of converting the images to bitmaps (bmp) or JPEGs (jpg). As with the 6040-A, there is an RS-232 port that is available for diagnostics. It communicates at 9600 bps to a VT100 type terminal with a data format of:

- 8 bits data;
- No parity; and
- One stop bit (8-N-1).

The DB-25 on the 6040i is configured as follows:

- pin 3 transmit;
- pin 2 receive; and
- pin 7 ground.

The VGA output could also be captured so that the baggage scan results could be appended to the passenger profile.

Interface Hardware/Translation

The Heimann Systems 6040i carry-on baggage scanner has a computer interface. The image data is stored to the connected computer. From the desktop computer via a network card (probably Ethernet) the image file could be moved to a central location for integration into the passenger file. The image will need to be converted from the proprietary format that Heimann uses. Heimann sells a software conversion utility which can convert the image to a common image format such as bitmap (bmp), JPEG (jpg), or TIFF (tif).

Hi-Scan 10050 EDS

The Heimann Systems Hi-Scan 10050 EDS is similar in operation to the Hi-Scan 6040-A upgraded with additional interfaces and functions. The Hi-Scan 10050 EDS is an X-ray machine designed to inspect checked baggage with capability to inspect carry-on baggage and other small items. The Hi-Scan 10050 EDS has an X-ray tube that generates a fan shaped beam that scans a slice of the baggage as it moves through the beam on the conveyor belt.

The image of the item under inspection is generated as the signals from the L-shaped detector array of photo diodes is detected and processed. A new scan is taken every 1 mm of physical motion of the item under inspection. Each scan (slice) of the item is processed and the results are presented on a colour or black & white display for viewing by the operator This system is film safe up to 1600 ASA.

Interface

The Heimann Systems Hi-Scan 10050 EDS system is a checked baggage screening device. The 10050 unit is hooked up to a standard off-the-shelf computer. This results in a variety of networking options being viable. Any network that can have a node installed on the host computer will be able to extract the images. As with the 6040i the data is stored in a proprietary Heimann format. A software conversion utility is available that can convert this image to a bitmap (bmp) or JPEG (jpg) image.

Interface Hardware/Translation

The Heimann Systems 10050 EDS checked baggage scanner has a computer interface that can be connected to an Ethernet network. The image data is stored to disk in the Hi-Scan 10050 EDS system. This interface can then be used to retrieve, store and transfer on command the stored X-ray images to a standard PC over a network card such as Ethernet. At the destination PC system these images can be converted into standard format such as bitmap (bmp), JPEG (jpg), or TIFF (tif) using OTS LINK software.

Trace Explosives Detection System

Barringer Technologies

Ionscan 400/400B

The Barringer Ionscan 400B functions are based on ion mobility spectrometry (IMS) technology. This technology allows for fast identification of many substances in very low concentrations. A weak Nickel 63 radioactive source is used to ionize the molecules passing the source. Typical sample analysis can take between 6.6 and 18 seconds to complete. The unit requires 15 minutes warm-up time from a cold start. The false alarm rate is less than 1 percent. Most narcotics can be detected in quantities as low as 1 ng (10^{-9} gram).

The IMS process used in the Ionscan 400 works by diffusing the test sample molecules (air, trace residue of explosives, etc.) through a membrane or filter into a chamber where a sealed Nickel 63 radioactive source ionizes the sample. Periodically (about 50 times per second) small portions of the ionized test sample are released into a separation region. An electric field moves the ions. Heavier ions (such as explosives) will take longer to traverse the length of the tube. At the end of the tube is an electronic device that records the quantity of ions passing it with respect to time. Based on these results specific compounds can be analyzed and identified.

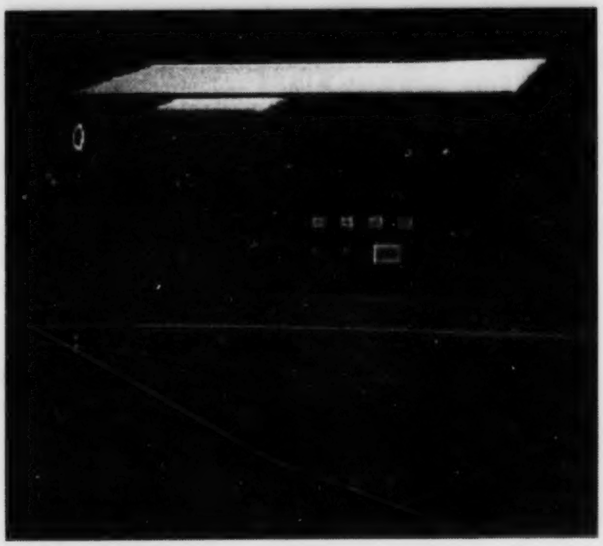


Figure D-4 Barringer Ionscan 400B

Interface

The Barringer Ionscan 400/400B is a trace explosives detection system. It has two RS-232 interfaces with DB-9 connectors, a printer interface with a DB-25 connector, an acoustic alarm, and an LED display (lamp). The Ionscan has no short-term or long-term internal storage capabilities. It can however be set to export data to a modem or computer through one of the serial communications ports or to a printer through the DB-25 parallel port connection. Barringer has software that simplifies programming the Ionscan 400B; however, all programming tasks can be performed from the unit itself.

The 400B can be configured to print the result of every scan it makes on completion of the process. This data could be sent to a computer using a parallel to serial interface converter and integrating this data with passenger records.

Intelligent Detection Systems (Scintrex)

The Orion Plus and the EVD-1 EVD-3000 Hand-Held Detector are both manufactured by Intelligent Detection Systems (Scintrex).

Orion Plus

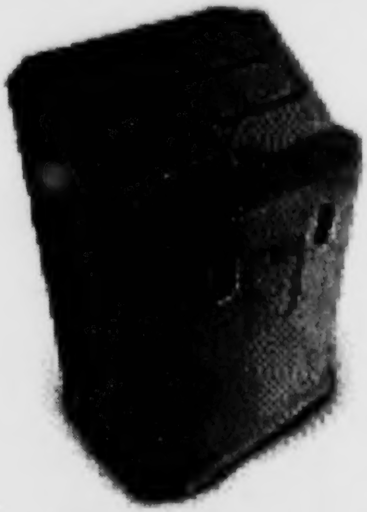


Figure D-5 Intelligent Detection Systems Orion Plus

EVD-1 EVD-3000 Hand-Held Detector

Figure D-6 Intelligent Detection Systems EVD-3000 Hand-Held Detector

Ion Track Instruments

ITEMISER

The Ion Track Instruments ITEMISER is a trace explosives detection system. The ITEMISER has an RS-232 port on it.

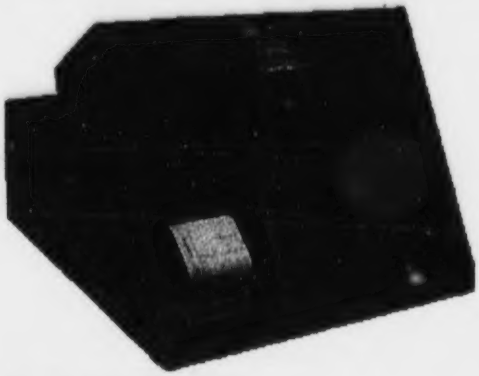


Figure D-7 Ion Track Instruments ITEMISER

Thermedics Detection

EGIS II

The Thermedics Detection EGIS II detection functions are based on Gas Chromatography with Chemiluminescence technology. The heated sample is mixed with inert (99.999% pure) helium gas and the mixture is injected into the chromatographic columns which consist of materials that absorb or retard the flow of the molecules of interest based on molecular size. This results in different molecules being released from the columns at variable times. The sample is continually heated to pyrolyze any explosive compounds into molecular fragments such as nitric oxide (NO). The chemiluminescent reaction of ozone (O_3) and nitric oxide for example, yields photons that can be optically detected. A microprocessor can then be used to count and analyze the number of photons observed. The resultant data showing molecular counts versus time can then be used to determine the quantity of molecules of various compounds present.

From a cold start the EGIS II unit requires approximately 60 minutes to warm-up before it can be used. Approximately 5 minutes is required for the EGIS II to function when operation is required from a warm start.

Figure D-8 Thermedics Detection EGIS II

Interface

The EGIS II has two RS-232 ports and one parallel printer port. These ports are consist of two DB-9 and one DB-25 connectors. The EGIS II can be configured to print all results to a printer attached to the DB-25.

Data can be extracted through a serial cable connected to a DB-9 port using the interlink function that comes with DOS 6.22.

Checked Baggage Screening

Heimann Systems

Hi-Scan 10050 EDS

The Heimann Systems Hi-Scan 10050 EDS is similar in operation to the Hi-Scan 6040-A but it is upgraded with additional interfaces and functions. The Hi-Scan 10050 EDS is an X-ray machine designed to inspect checked baggage with capability to inspect carry-on baggage and other small items. The Hi-Scan 10050 EDS has an X-ray tube that generates a fan shaped beam that scans a slice of the baggage as it moves through the beam on the conveyor belt.

The image of the item under inspection is generated as the signals from the L-shaped detector array of photo diodes is detected and processed. A new scan is taken every 1 mm of physical motion of the item under inspection. Each scan (slice) of the item is processed and the results are presented on a colour or black & white display for viewing by the operator. This system is film-safe up to 1600 ASA.

Interface

The Heimann Systems Hi-Scan 10050 EDS system is a checked baggage screening device. The 10050 unit is hooked up to a standard off-the-shelf computer. This results in a variety of networking options being viable. Any network that can have a node installed on the host computer will be able to extract the images. As with the 6040i the data is stored in a proprietary Heimann format. A software conversion utility is available that can convert this image to a bitmap (bmp) or JPEG (jpg) image.

Interface Hardware/Translation

The Heimann Systems 10050 EDS checked baggage scanner has a computer interface. The image data is stored to the connected computer. From the desktop computer via a network card (probably Ethernet) the image file could be moved to a central location for integration into the passenger file. The image will need to be converted from the proprietary format that Heimann uses. Heimann sells a software conversion utility which can convert the image to a common image format such as bitmap (bmp), JPEG (jpg), or TIFF (tif).

AS&E

101ZZ

The American Science and Engineering 101ZZ is an X-ray scanning system that utilizes multiple sensor technologies to collect transmission and backscattered X-ray signals to build images of the contents of checked baggage. Transmission image data are obtained from energy that directly penetrates the baggage, whereas backscatter image data are obtained from energy that did not penetrate the baggage and was scattered back towards the X-ray source. The 101ZZ gathers both transmission X-ray data and the backward scattered X-ray signals to create an image of the baggage contents. In addition to gathering direct and backscatter X-ray image data, the 101ZZ can also generate high and low energy beams.

Combining all three sensor modalities can improve the probability of explosives detection and reduce false alarm rates. The AS&E system uses a unique method of generating the scanning X-ray beam by using a "flying-spot" technology, which provides very high quality X-ray images from all three sensors.

The Model 101 series of MICRO-DOSE Inspection Systems uses AS&E's patented "flying spot" X-ray scan technology (shown in Figure D-9). Radiation generated by an X-ray tube is collimated by combining a long stationary slit and a rotating wheel with four slits to produce a pencil-size X-ray beam. This X-ray beam rapidly scans a parcel as it moves through on a conveyor. X-rays that collide with the parcel are absorbed by the parcel, scattered off the parcel, or transmitted through the parcel. For the Model 101ZZ system, two detector systems generate images for display: one detector system for the transmitted image and the second detector system for the backscattered image. The detector signals are sampled, digitized, and stored in digital display processors for display on two high resolution 15-inch video monitors. The backscatter monitor's split screen displays backscatter images from both sides of a parcel simultaneously.

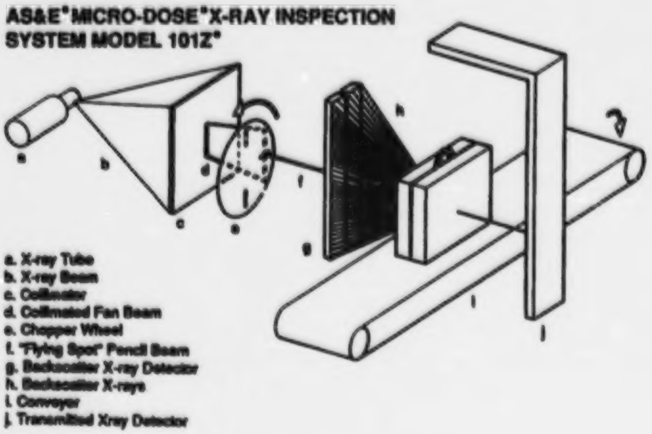


Figure D-9 Simplified Diagram of 101ZZ X-ray Scanning System

The basic 101ZZ system provides very limited automated explosives detection features and requires manual control of the detected image data to enhance the image. Data collection and analysis are performed by an operator through the use of control functions on the operator control panel. The 101ZZ is equipped with two X-ray sources and three detectors, a transmission and backscatter for one side of the baggage, and a backscatter detector for the other side. The 101ZZ is equipped with a computer controllable X-ray source controller, and two infrared beam break sensors used to determine the position of the baggage on the conveyor belt.

A typical X-ray imaging system includes a radiation source to generate the X-ray field, and a detector to convert X-ray energy to an electrical signal. The source and detector are placed on opposite sides of the X-ray tunnel, directly across from each other. The detector is used to measure the attenuation of the X-ray energy, called the transmission energy, as it penetrates through the object of interest.

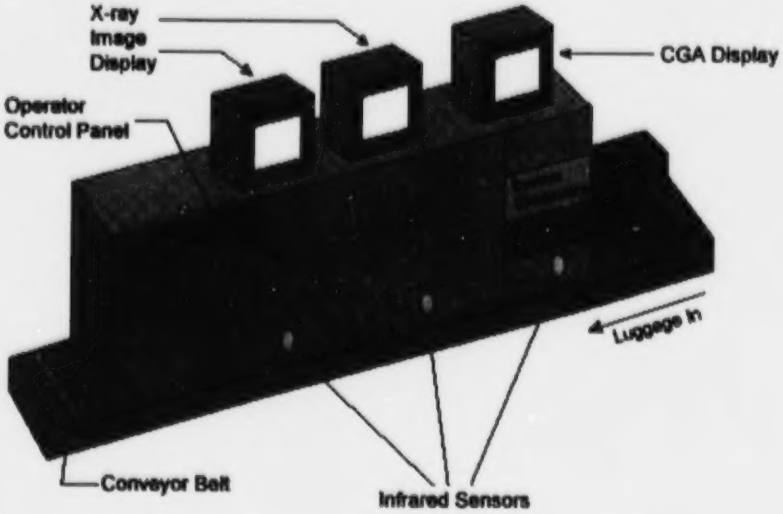


Figure D-10 AS&E 101ZZ Checked Baggage Scanning System Block Diagram

Early security systems used high energy X-ray for the detection of weapons. At higher energy levels (over 100 KV), the absorbed energy depends primarily on the density of the material: the higher the density, the more energy is absorbed by the object, therefore the darker the image. A metal object, such as a weapon, or an explosive device, both dense materials, would appear very dark in the transmission image and would be detected. However, an explosive device could be concealed behind a denser material, making it invisible to the system operator.

Interface

The AS&E 101ZZ is a checked baggage screening system. The 101ZZ unit has an RS-232 Serial interface port and a parallel printer port. It is not known what the interface protocols are or what the data format is for each of these ports.

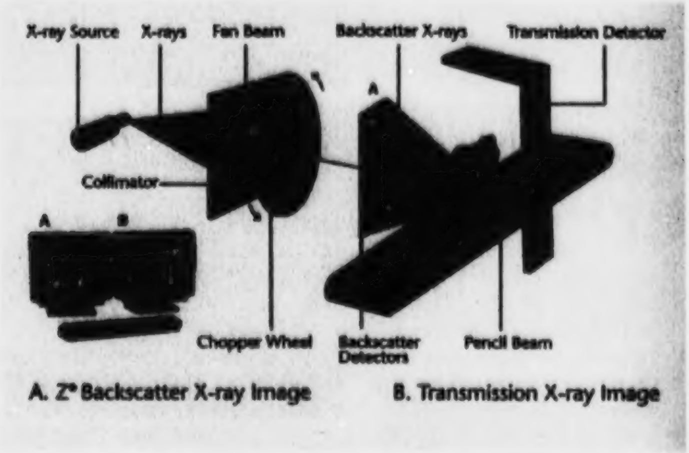


Figure D-11 Z Backscatter X-ray Imaging Concept

To resolve this problem, baggage is scanned at two energy levels. At lower energies (usually 80 KV), the absorption depends mainly on the effective atomic number (Zeff), as well as the thickness of the material. Using multi-energy transmission images, high density and low Zeff explosives can be identified. A system that uses two X-ray energy levels for scanning is called a dual-energy system. Several techniques exist for the collection of multi-energy images, including varying the input energy of the X-ray source, filtering the energy at the X-ray sensor and using multiple sensors with different spectral responses.

EG&G Astrophysics

Z-SCAN 7

The EG&G Astrophysics Z-SCAN 7 operation is based on two-view, dual-energy, automatic X-ray scanning technology. The dual-energy scanning system works by merging the data from a horizontal and vertical X-ray beam scan. Through the merging of these two images, a three-dimensional density map of the target can be formed and light elements such as carbon, oxygen, and nitrogen can be easily detected. Dual-energy scans provide more information than standard X-ray scans because they can help differentiate between very little of a highly absorbent material and a lot of a low absorbent material.

The Z-SCAN 7 is a large automatic X-ray system typically used for high speed screening of checked baggage destined for holds for aircraft. This system can be integrated directly into an airport baggage conveyor system. This system has a 1.4mm by 1.4mm scanning resolution of the items under observation. One of the system views has a 736 diode detection array for low energy detection and a second diode array of 736 diodes for high energy detection. The other view consists of 704 by 704 detectors. The Z-Scan 7 creates two 2-D images by processing the different images for the elimination of background signals. In the processing and analysis operation, the Z-Scan 7 defines each object with its atomic number. These images are then combined to form a 3-D picture of the target. The 3-D picture is then analyzed for restricted materials. The resolution is detailed enough for 38-gauge copper wire to be visible. The Z-Scan 7 can process up to 1000 bags per hour.

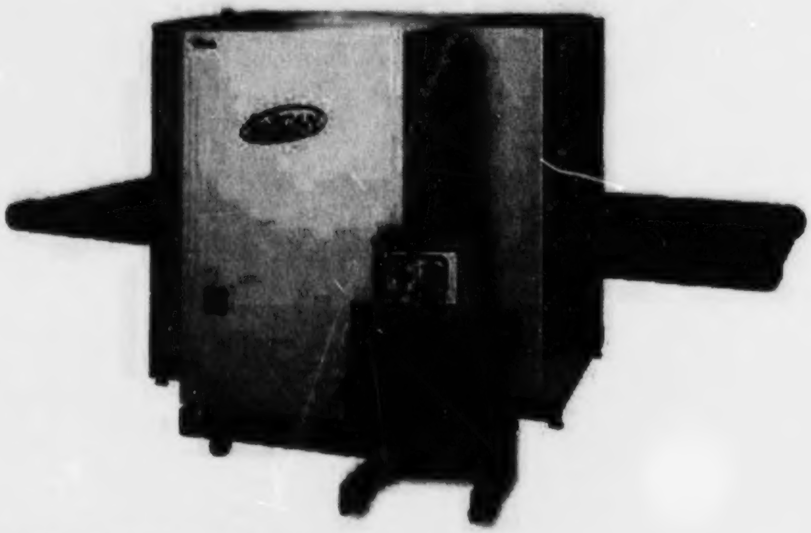


Figure D-12 EG&G Astrophysics Z-SCAN 7

Interface

The EG&G Astrophysics Z-Scan 7 is a checked baggage screening system. The Z-Scan 7 has a 100Mbit/s Ethernet connection that uses either fibre or twisted pair cabling.

Z-SCAN 12

EG&G Astrophysics, the world's leading supplier of X-ray security screening systems and metal detectors, provides security equipment to airports, correctional institutions, government, courthouses, hospitals and schools. More than two-thirds of all commercial airports in the world use EG&G X-ray technology to screen baggage for explosives, firearms, weapons and drugs.

The EG&G Astrophysics Z-SCAN 12 operation is based on two-view, dual-energy, automatic X-ray scanning technology. The dual-energy scanning system works by merging the data from a horizontal and vertical X-ray beam scan. Through the merging of these two images, a three-dimensional density map of the target can be formed and light elements such as carbon, oxygen, and nitrogen can be easily detected. Dual-energy scans provide more information than standard X-ray scans because they can help differentiate between very little of a highly absorbent material and a lot of a low absorbent material.

The EG&G Astrophysics Z-Scan 12 is a medium size automatic X-ray system typically used to screen hold baggage at the airport check-in concourse. The Z-SCAN 12 is currently in use at airports in the Far East and Europe.

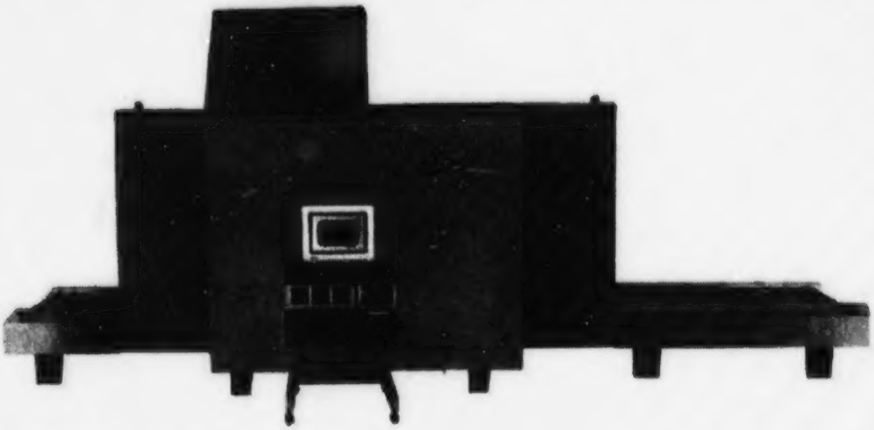


Figure D-13 EG&G Astrophysics Z-SCAN 12

InVision

CTX 5000 SP

InVision's CTX 5000 SP operation is based on X-ray and CT technology. The X-ray results determine how many CT slices are to be made and where to accurately inspect the baggage. The CT slices are automatically analyzed for explosive materials. The CT scanned slices are used to help detect thin sheet explosive material. Baggage can be scanned at an average rate of 150 bags per hour in the US and 240 bags per hour in Europe. This rate takes operator decision time into account. The average false alarm rate is in the 20-30 percent range in automated operation.

The CTX 5500 DS is InVision's second generation of BEDS scanning system. This system is an enhanced version of the CTX 5000 SP, FAA-certified automated explosive detection system (EDS), designed to screen checked passenger baggage. CTX systems combine transmission X-ray, computed tomography (CT) and sophisticated automatic inspection software to provide the highest detection available.

Improving upon the performance of its predecessor, the CTX 5000 SP, the CTX 5500 DS is the first "intelligent" EDS to be developed for hold baggage screening. This intelligence is applied to both the automatic and operator inspection processes and provides airports with the ultimate screening flexibility. The CTX 5500 DS can also operate over 30 percent faster than the CTX 5000 SP and can be configured to automatically detect narcotics.

Dynamic Screening™ allows CTX to automatically monitor the security status of each bag via a direct interface with the airport's baggage handling system. CTX then automatically selects the appropriate screening software on a bag-by-bag basis by considering the level of suspicion and the number of bags waiting in the queue.

Advanced Threat Resolution (ATR)™ automatically focuses the operator's attention on the specific objects rejected by the automatic inspection algorithms. A redesigned user interface makes commonly used functions easily and quickly accessible. The software even automates part of the operator's inspection process making threat resolution faster and more reliable.

CTX is also the first EDS to apply Threat Image Projection or TIP. TIP periodically displays images of bags containing real explosives to operators while they work and records their on-the-job performance.

Figure D-14 InVision CTX Theory of Operation

The InVision CTX 5000 SP can be upgraded into the DS version of the product. These upgrades improve the airport security measures and give enhanced performance features of the CTX 5500 DS system. The CTX 5500 DS screens baggage at a rate of up to 370 bags per hour — 30 percent faster than the CTX 5000 SP with a lower false alarm rate at a comparable cost. It also provides a redesigned operator console with an improved graphic user interface and can train and test operators on a continuous basis.

InVision's CTX 5000 SP system is a checked baggage tool that could be adapted to screen carry-on baggage.

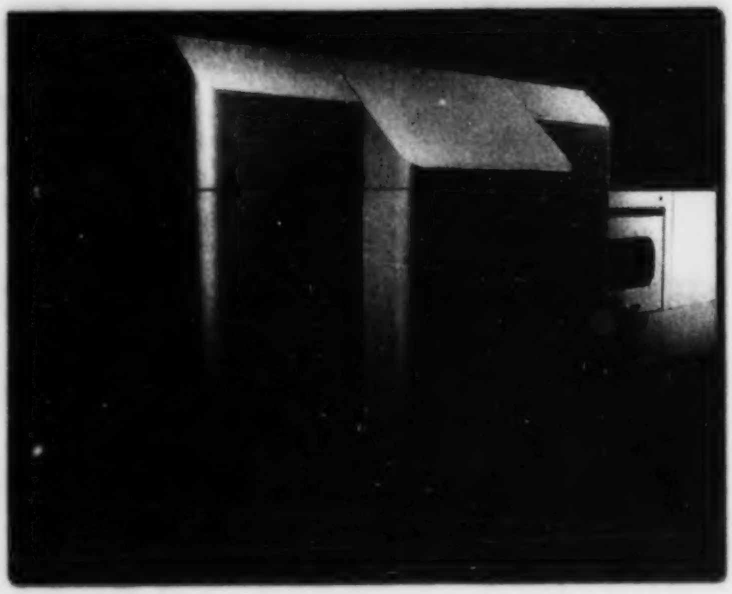


Figure D-15 InVision CTX 5000 SP

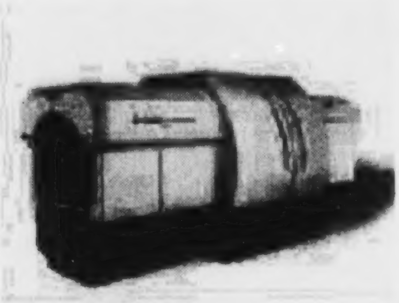
Interface

The CTX 5000 SP has a modem, a VGA port, and 64 contact closures that could be used to communicate the threat status of baggage. The contact closures are for communication with the airports Programmable Logic Controller (PLC) which controls the baggage conveyor. The modem operates at selectable data rates between 9.6 kbps and 33.6 kbps. It is unknown what services that modem provides access to or exactly how the data gets to the Level 3 workstations. The Level 2 workstation is directly attached to the scanner. The VGA output could be captured so that the baggage scan results could be appended to the passenger profile.

CTX 9000 DSI

CTX 9000 DSi is an innovative checked baggage scanning system specifically designed for seamless integration into an airport's baggage handling system. The CTX 9000 DSi offers practical advantages and incorporates a "wish list" of new features such as a high-speed data link with fibre optic connections, self-contained environmental control unit, and a modular detector array for easy access and repair.

The CTX 9000 DSi has successfully completed FAA-certification testing in April 1999 at a baggage throughput rate of 542 bags per hour, making it the fastest certified EDS in the world. The CTX 9000 DSi combines the low false alarm rates and high detection rates of the CTX series with a number of significant enhancements and new features. The CTX 9000 DSi's certified throughput rate is substantially faster than that of the company's current model, the CTX 5500. The new EDS offers very high image resolution for enhanced object examination by system operators. It also has the widest aperture of any certified checked baggage screening device, which allows for easier integration with baggage handling systems in airports. InVision intends to continue to manufacture and sell the CTX 5500 for lower throughput applications.



CTX 9000 DSi

Figure D-16 CTX 9000 DSi

"The certification of the CTX 9000 DSi represents the culmination of a two-year effort that was made possible by the support of several entities. InVision would like to recognize the Gore Commission, which refocused the priorities and the funding for aviation security; the support of the FAA and its Technical Center in Atlantic City, which provided outstanding program management; our customers, who, over time, provided invaluable feedback on the performance of our deployed CTX 5000 series; and finally our engineering team that developed the CTX 9000 DSi in less than two years, " said the president of InVision.

The CTX 9000 DSi offers the following features and benefits:

- Fastest FAA-certified EDS, certified at 542 bags per hour.
- Real-time EDS – the only EDS available today that performs real-time baggage scanning, providing immediate results to operators as soon as each bag clears the machine.
- 1-metre wide conveyor belt system, widest of any certified checked baggage screening device for seamless integration with airport baggage handling systems.
- Active X-ray shielding curtains that move vertically to rapidly open and close the X-ray chamber. These enhance the system's safety and facilitate its high baggage throughput rates.
- Future support for:
- Multiple detector rings to significantly improve performance;
    - Additional inspection modes of the CTX 5000 family that provide a choice of detection and false alarm rate capabilities and make possible baggage throughput rates of up to 800 bags per hour.

L3 Communications

eXaminer 3DX 6000

The eXaminer 3DX 6000 incorporates computed tomography (CT) scanning technology as well as detection algorithms for sheet-like forms of explosive. It is capable of generating three-dimensional images of all objects in bags and is a single-unit, second-generation system certified by the FAA.

The 3DX 6000 utilizes Analogic's EXACT™ AN6000 technology which is a dual-energy, helical-cone-beam, multi-slice computed tomography (CT) system that provides a complete set of CT images of an entire three-dimensional object as it passes along the baggage conveyor. The system includes a high efficiency, wide dynamic range, solid-state X-ray detector array consisting of 6048 detectors. Rotating at 90 RPM, this system takes up to 720 sets of 6048 measurements per rotation every two-thirds of a second. The system presents both projection and axial images of this moving object for analysis by the operator.

The EXACT technology is the heart of the eXaminer 3DX™ 6000 explosive detection system (EDS), the first single-unit, second-generation EDS, FAA certified and developed in co-operation with L3 Communications. The EXACT is also the system of choice for detection of drugs and other prohibited materials. Equipped by ISS with workstations and algorithms unique to L3 Communications for US Customs Service drug and prohibited material detection, the EXACT has been successfully demonstrated the detection of small quantities of prohibited materials.

A customized VersaLogic STD 32 Bus CPU card is used in the detection and display portion of the eXaminer 3DX™ 6000. A second VersaLogic processor board combined with a high-speed analog and digital I/O card controls the high-speed rotating disk, solid-state X-ray detector array consisting of 6048 detectors and plays an important role in communications for the 6000 channels of data transmission. The CT's disk, which spins around the object being scanned at 90 RPM, operates at a constant centrifugal force in excess of 10 G's. The rugged design of VersaLogic's STD 32 Bus system is a perfect fit for this demanding environment.

Sophisticated software automatically isolates bag contents unambiguously and analyzes them, evaluating them against the known characteristics of explosives or narcotics. If a match is found, the system alerts the operator, highlights the area of concern for further analysis, and provides a full rotating 3-D image of the potential threat.

The 3DX 6000:

- generates full 3-D images of all objects in every bag;
- gathers all necessary data in one pass;
- requires only 6 seconds per scan;
- isolates and analyzes the entire contents of each bag automatically;
- acquires ten times more data per bag than first-generation systems;
- handles up to 600 bags per hour;
- utilizes modular design for high reliability and easy maintenance; and
- meets all FDA cabinet X-ray requirements.

The eXaminer 3DX 6000 exceeds the FAA's requirements for identification of plastic explosives in passenger checked baggage and for rapid bag throughput with a low false alarm rate. The eXaminer 3DX 6000 has capabilities superior to first-generation systems. It is the first EDS to provide multiple, simultaneous and continuous computed tomography (CT) images to examine an entire bag in one pass, analyzing 10 times more data per bag than the existing generation of machines. The new system has been certified to process 500 bags per hour. The eXaminer 3DX 6000 is also approximately half the size and weight of first-generation explosive detection systems, a key feature given limited airport space.

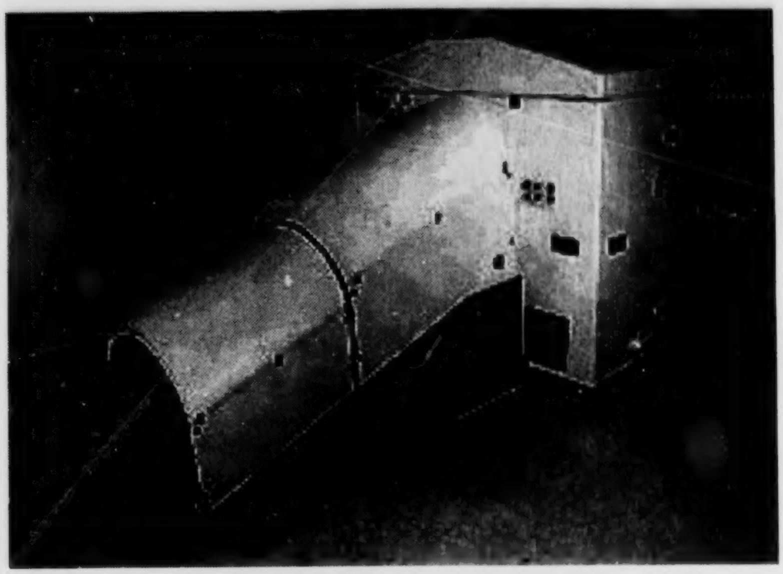


Figure D-17 L3 Communications eXaminer 3DX

The eXaminer 3DX 6000 is the first FAA-certified system to generate full, three-dimensional images of all objects in bags. The system then automatically isolates and quickly analyzes every item against the characteristics of explosive materials. If a match is found, the system alerts the operator, highlights the area of concern for further analysis with a full rotating 3-D image of the potential threat, and then isolates the bag for appropriate action. The CT scanner also has the potential for detecting narcotics and other restricted substances.

Explosive Detection

Figure D-18 eXaminer 3DX Picture

The picture in Figure D-18 shows the resolution and quality of the scanned and processed image from the L3 Communications eXaminer 3DX system.

Interface

The eXaminer 3DC is the newest generation (1999) design of a checked baggage screening system. The eXaminer 3DX technical information has not been released at this time and data interface data has not been made available.

Vivid Technologies

VIS-M Automatic Level 1

The Vivid Technologies VIS-M Automatic Level 1 functions are based on a vertical beam, dual-energy X-ray technology. The dual-energy scanning works by merging the data from a horizontal and vertical X-ray scan. Through the merging of images, a three-dimensional density map can be formed and light elements such as carbon, oxygen, and nitrogen can be easily detected. Dual-energy scans provide more information than standard X-ray scans because they can help differentiate between very highly absorbent material and low absorbent material.

The Vivid Technologies VIS-M Automatic Level 1 functions are based on a vertical beam, dual-energy X-ray technology. The detector subsystem is an L-shaped array of 960 detectors. Approximately 500,000 pixels of data are obtained from each energy level for each scan as the item under observation passes through the machine. These pixels are grouped into tens of thousands of regions that are merged to form hundreds of objects. Each detected object's shape and thickness are electronically isolated, stored and compared at high speed to a series of predetermined threat objects. Multilevel energy level comparisons of the data are performed to detect a wide variety of explosives and prohibited materials. The Level 1 system can automatically process a bag every 2.4 seconds or 1500 bags per hour. The system continuously monitors all safety interlocks and incorporates extensive self-tests to ensure proper operation.

Figure D-19 Vivid VIS-M Automatic Level 1

Interface

The Vivid VIS-M Level 1 unit is an automatic checked baggage scanner. It has an FDDI interface which operates at 100 Mbit/s. When baggage is deemed suspicious, the relevant information is sent to a Level 2 workstation by FDDI. If the baggage is not cleared at the Level 2 workstation then it is sent, by FDDI, to a Level 3 workstation for a more detailed inspection. The information from all levels can be extracted by other computers on the FDDI network. For security reasons the Level 1 scanner and workstations can only have their options changed if a valid key card is inserted.

VDS II with Scatter Detection Enhancement (SDE)

The VDS II is a manually operated Level 3 inspection processor for checked baggage and is often the final arbiter before a suspect bag is boarded onto the aircraft or reconciled with the passenger. As much information as possible should be presented to the Level 3 operator to make this decision with a high degree of confidence. The Vivid Model VDS-II can also be configured as a Level 3 inspection system. The Level 3 version offers extended threat investigation capability along with the ability for the operator to view the bag from different angles. The VDS-III is a cost-effective solution for those seeking an automated system with imaging capability for high confidence Level 3 inspection.

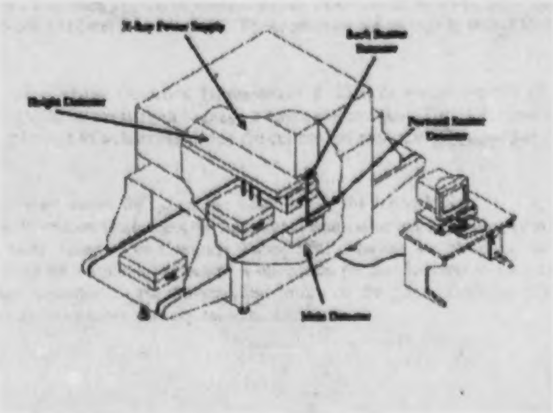


Figure D-20 Cutaway View of VDS II Level 3 Checked Baggage Screening Machine

Detailed Information and Specification packages have been developed for each system. Information and Specification documents for each model include integration and installation information as well as space and facility requirements. Detailed maintenance and operation manuals are also available. This information is available by contacting Vivid's offices in the UK or the USA.

Figure D-21 VDS II Level 3 Checked Baggage Screening Station

Boarding Gate Systems

KLM System Services

KLM Systems Services has designed and developed an automated boarding control system for speeding passenger boarding process and integrating this process with other airline functions such as passenger checked baggage and the airline reservation system. This data has been retrieved from the KLM Services web site http://systemsservices.klm.com/

Automated Boarding Control

Automated boarding control (ABC) is a tool to make the boarding process more accurate and faster. A boarding pass reader is placed at the gate to read the magnetic stripe on the back of the boarding pass. Based on the information contained on this "mag-stripe" the automated boarding control program decides if the passenger is allowed to board the aircraft.

Automated boarding control normally runs on SITA CUTE-2/OS equipment. It is also possible to run ABC on a less expensive stand-alone PC-DOS network. This not only reduces the costs, but can virtually be installed everywhere.

Features of the automated boarding control system:

- Automated boarding control constantly receives updates from the Departure Control System (DCS) and downloads again to the DCS the information on boarded passengers.
- Automated boarding control runs independent from the Departure Control System (DCS) Mainframe, meaning that boarding can continue while either the mainframe or communication lines are down.
- ABC also stores various passenger data enabling it to produce different lists on request.
- ABC can be controlled via different options to be switched on or off as the situation requires.
- ABC allows boarding through Gate-readers as well as the PC. The PC has the additional ability to board a maximum of 10 passengers in one entry.
- ABC logs all error messages generated ranging from Error through Warning to Information.
- ABC can be performed for multiple flights at the same gate, adding to a more flexible use of gate-areas.

Automated Boarding Control:

- improves the boarding process;
- causes fewer boarding discrepancies resulting in less frequent and shorter delays;
- improves departure punctuality;
- realizes shorter turn-around time or Minimum Connection Time;
- leaves staff free for problem solving or service improvements; and
- allows more efficient handling of special cases.

Interface

This type of terminal equipment is already fully integrated into the airline reservation system through the standard communications I/O port and protocol that each company uses. This terminal equipment communicates to the airline system continuously when online, using both local LAN connections and WAN links from the regional centres to the airline reservation system computers. The integration of this system is already complete and will not require any additional work.

In addition to communicating to the airline reservation system, these terminals communicate to the other systems located at the airports as required. These systems could be the Baggage Reconciliation System, and the automated boarding control Systems (if installed).

Baggage Reconciliation System

KLM System Services

KLM Systems Services has designed and developed a Baggage Reconciliation System for speeding the passenger boarding process and implementing baggage reconciliation functions in an automated way into the normal airline methods of operation. This baggage reconciliation process has been integrated with other airline functions such as passenger checked baggage and the airline reservation system. This data has been retrieved from the KLM Services Web site http://systemsservices.klm.com/

Interactive Baggage Reconciliation Information System

Interactive Baggage Reconciliation Information System (IBRIS) monitors the movement and loading of passenger baggage from check-in to departure. It is aware of all flights and their assigned gates. Using bar code scanners, IBRIS rapidly and accurately monitors baggage through the airport cellars or make-up areas to the correct ramp location for loading. Baggage containers and carts are also managed and the system allocates a container or cart to a specific flight and records all passenger baggage that is loaded. As baggage is loaded into containers, the handler is advised if the item can be loaded and a manifest is dynamically built.

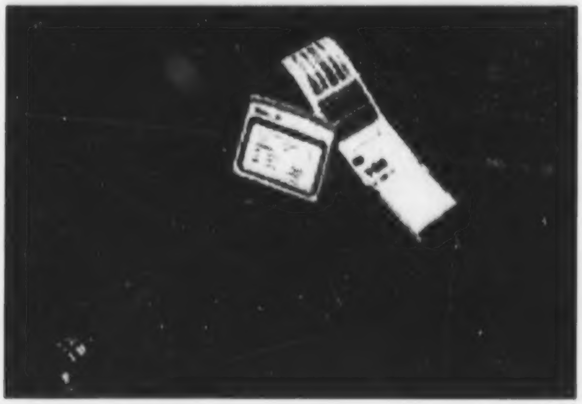


Figure D-22 IBRIS Baggage Tag Reader

As containers are loaded into the aircraft hold, a comprehensive layout of the baggage hold is painstakingly recorded by IBRIS. If however the baggage is loose loaded, it then records the selected hold. If a bag has to be offloaded for some reason, its location is known, allowing it to be retrieved with minimal delay to the flight. The system provides a comprehensive range of management reports as well as generating operational documentation such as container sheets.

The Interactive Baggage Reconciliation Information System manages the entire baggage reconciliation function including transfer baggage. It helps to manage the performance and productivity of the handling process.

IBRIS features:

- total baggage control;
- baggage reconciliation;
- baggage monitoring;

- barcode symbology scanning;
- wireless radio frequency communication;
- an open client/server architecture;
- standard IATA messages for interfacing;
- open to any Departure Control System architecture;
- increased security; and
- reduced baggage handling costs.

Baggage reconciliation is a security necessity. IBRIS ensures reconciliation is achieved effectively and efficiently through automated techniques in accordance with security requirements. Baggage reconciliation is a mandatory security measure as prescribed by the International Civil Aviation Organization in Annex 17 and defined in States National Civil Aviation Security Programs.

IBRIS allows an organization to improve staff efficiency. Baggage handlers are provided with ergonomic tools to assist them to accurately and efficiently load and unload baggage, prepare containers and reconcile baggage with passengers. The automated processes improve productivity and provide statistics and management reports that allow resources to be dynamically allocated to tasks based on priority.

IBRIS cuts operating costs by monitoring baggage movement and automating the reconciliation process so that significantly less baggage is delayed or misdirected. Additionally IBRIS reduces the time that flights may be delayed due to a need to offload certain baggage. It provides a series of early warnings, allowing management to initiate corrective actions such as the rapid passage of transfer baggage due to a pending flight departure. IBRIS has been built in accordance with all applicable IATA standards and allows interfaces to various Departure Control, Flight Information and Baggage Handling systems to be achieved with ease. The client/server architecture provides high availability and performance. The technology is based on open operating, database management and communications standards.

IBRIS conforms to all international requirements in a fully automated fashion. All items of baggage are monitored and controlled, including transfer items, containers and carts. The Interactive Baggage Reconciliation Information System allows airlines, airport authorities and baggage handling agents to efficiently manage passenger baggage, improve security and customer service, and reduce operating costs through total baggage control.

The system fully adheres to international air transport standards and uses generally accepted and proven information technology products and practices.

IBRIS allows efficient baggage management, meets security commitments and reduces costs by streamlining baggage movement, thus almost eliminating misdirected and delayed baggage. The ultimate winner is the customer who will be better served.

Interface

This equipment is already fully integrated into the airline reservation system through the standard communications I/O port and protocol. This equipment communicates to the airline system continuously when online using both local LAN connections and WAN links from the regional centre to the airline reservation system computers. The integration of this system is already complete and will not require any additional work.

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APPENDIX E – EQUIPMENT DATA MATRICES

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	Maker	Model	Applications	Distributed By	Manufactured By	Request Sent	Respse	Power Requirements	Interface Protocol or Connection	Data Protocol	Data Requirement Output	Manuals Received	Contact Person	Visit Date	Comment
1	Garrett	Superscanner	Hand Held Metal Detector	Heimann Systems Inc. 950 Berger Laval, Quebec H7L 5A1 Canada tel: 450-967-0010 fax: 450-967-7444 Cherif Rizkalla HS-canada@heimannsystems.com	Garrett Metal Detectors 1881 State Street Garland, TX 75042 USA tel: 214-278-6151 fax: 214-271-0186 wat: 800-234-6151 Beverly Trollinger ** beverlyt@garrett.com www.garrettmetaldetectors.com	12-Jun	NA	Battery	Tone alarm	None	None	NONE	Beverly Trollinger		
2	CEIA	02PN10 Security Metal Detector	Walk Through Metal Detector	CEIA USA 9177 Dutton Drive Twinsburg, OH USA tel: 330-405-3190 fax: 330-405-3196 Scott Dennisson www.ceia-usa.com	Costruzioni Elettroniche Industrial Automatismi Zona Industriale 52040 Viciomaggio (Arrezzo) Italy tel: +39 575 4181 fax: +39 575 418290	12-Jun	NA	115/240 Vac 45/65 Hz 30 VA	RS-232 Interface Tone alarm Lamp Indicator Relays LED Bar graph Keyboard	Proprietary	None	Technical Manual, Walk-Through Metal Detector, Mod.:02PN10/PN-TR-600; November 26, 1996.	None		
3	Heimann Systems	HI-SCAN 6040-A	Carry-On Baggage Screening	Heimann Systems Inc. 950 Berger Laval, Quebec H7L 5A1 Canada tel: 450-967-0010 fax: 450-967-7444 Cherif Rizkalla HS-canada@heimannsystems.com	Heimann Systems GmbH Carl-von-Linde Strabe 14 65197 Weisbaden Germany tel: ++49 611 9412 0 fax: ++49 611 9412 229 www.heimannsystems.com	12-Jun	YES	230 Vac 50/60 Hz 0.6 kVA	RS-232 VGA Video	Proprietary		HI-SCAN 6040-A Version 3.1, X-ray Inspections System Manual; May 6, 1997. HI-SCAN 6040-A Version 3.1, X-ray Inspection System, Technical Manual; October 31, 1995. HI-SCAN X-ray Inspection Systems with HI-VIEW Technique, Operating Manual; May 5,1997. HI-SCAN X-ray Inspection Systems, Module Descriptions; March 9, 1995.	None		
4	Barringer Technologies	Ionscan 400/400B	Trace Explosives Detection System TEDS	Barringer Technologies Inc. 1730 Aimco Boulevard Mississauga, ON L4W 1V1 Canada tel: 905-238-8837 fax: 905-238-3018 Kim Lena Ron Jackson ** www.barringer.com	Barringer Technologies Inc. 1730 Aimco Boulevard Mississauga, ON L4W 1V1 Canada tel: 905-238-8837 fax: 905-238-3018 Kim Lena Ron Jackson ** www.barringer.com	12-Jun	YES	95 TO 255 Vac 50/60 Hz	RS-232 Parallel Port Tone Alarm Display LED Alarm Ind.	Proprietary uses Ymodem Protocol		IONSCAN Model 400B, Operator's Manual Rev. C; April 22, 1999.	Ron Jackson		
5	Intelligent Detection Systems (Scintrex)	Orion Plus	Trace Explosives Detection System TEDS	Intelligent Detection Systems (Scintrex) 152 Cleopatra Drive Nepean, ON K2G 5X2 Canada tel: 613-224-1061 fax: 613-224-2803 Mr. Kalid Batar / Shelly Romain Brian Rich ** www.idsdetection.com	Intelligent Detection Systems (Scintrex) 152 Cleopatra Drive Nepean, ON K2G 5X2 Canada tel: 613-224-1061 fax: 613-224-2803 www.idsdetection.com	12-Jun 9-Aug 31 Aug	YES	110/220 Vac 50/60 Hz	LCD Display	None		The ORION/ORION Plus User Guide 2nd edition, Dec 3, 1998	Brian Rich		
6	Intelligent Detection Systems (Scintrex)	EVD-1 EVD-3000 Hand Held Detector	Trace Explosives Detection System TEDS	Intelligent Detection Systems (Scintrex) 152 Cleopatra Drive Nepean, ON K2G 5X2 Canada tel: 613-224-1061 fax: 613-224-2803 Mr. Kalid Batar / Shelly Romain Brian Rich ** www.idsdetection.com	Intelligent Detection Systems (Scintrex) 152 Cleopatra Drive Nepean, ON K2G 5X2 Canada tel: 613-224-1061 fax: 613-224-2803 Mr. Kalid Batar / Shelly Romain Brian Rich ** www.idsdetection.com	12-Jun 9-Aug 31 Aug	YES	12 Volt Battery (rechargeable). Operates for a minimum of 60 minutes/Batt Charge.	RS-232 LED Alarm Ind.	None		The EVD-3000 Hand held explosives detector User Guide 8th edition Jan 15, 1999	Brian Rich		
7	Ion Track Instruments	ITEMISER	Trace Explosives Detection System TEDS	Ion Track Instruments 205 Lowell Street Wilmington, MA 01887 USA tel: 978-658-3767 fax: 978 657-5964 Ms Laura Zampell www.iontrack.com	Ion Track Instruments 205 Lowell Street Wilmington, MA 01887 USA tel: 978-658-3767 fax: 978 657-5964 Ms Laura Zampell www.iontrack.com	20-Jul	NO	110/220 Vac 50/60 Hz	RS-232 LED Alarm Ind.	Unknown		NONE	Laura Zampell		

ASDF_Matrices_RevF.xls ** is main contact person for technical data

	Maker	Model	Applications	Distributed By	Manufactured By	Request Sent	Respse	Power Requirements	Interface Protocol or Connection	Data Protocol	Data Requirement Output	Manuals Received	Contact Person	Visit Date	Comment
8	Thermedics Detection	EGIS RAMPART now EGIS II	Trace Explosives Detection System TEDS	Thermedics Detection, Inc. 220 Mill Road Chelmsford, MA 01824-4178 USA tel: 978-251-2023/2000 X 2049 fax: 978-251-2010 Mr. Dan Dussault www.tdxinc.com	Thermedics Detection, Inc. 220 Mill Road Chelmsford, MA 01824-4178 USA tel: 978-251-2023/2000 X 2049 fax: 978-251-2010 Mr. Dan Dussault www.tdxinc.com	14-Jun	YES	115/230 Vac 10%. 50/60 Hz 15 A @ 115 V 7.5 A @ 230 V	RS-232 Parallel Port Display LED Alarm Ind.	Proprietary		EGIS II Operation and Maintenance Rev. A; 1999.	Dan Dussault		
9	Heimann Systems	HI-SCAN 6040-I	Carry-On Baggage Screening	Heimann Systems Inc. 950 Bergar Laval, Quebec H7L 5A1 Canada tel: 450-967-0010 fax: 450-967-7444 Cherif Rizkatta HS-canada@heimannsystems.com	Heimann Systems GmbH Carl-von-Linde Strabe 14 65197 Weisbaden Germany tel: ++49 611 9412 0 fax: ++49 611 9412 229 www.heimannsystems.com	12-Jun	YES	230 Vac 50/60 Hz 0.6 kVA	RS-232 Video Connection 15 pin Ethernet 10 Mb	Proprietary		See Heimann System manuals for HiSCAN 6040-A.	None		
10	AS&E	101ZZ	BEDS - Checked carry-on-baggage screening	American Science & Engineering 829 Middlesex Turnpike Bellerica, MA 01821 USA tel: 978-262-8700 fax: 978-262-8803 Ms. Nancy Babbidge David Hack ** www.as-e.com	American Science & Engineering 955 Massachusetts Avenue Cambridge, MA 02139 USA tel: 617-868-1600 fax: 617-	14-Jun	YES	115/230 Vac 10%. 50/60 Hz Single Phase < 15 Amps	VCR Comp Video Parallel Port Display LED Alarm Ind.	Proprietary		Operators Manual for Series 101 X-ray Inspections System 18 June, 1999	David Hack		
11	EG&G	Z-Scan 7	BEDS - Checked baggage screening	EG&G Astrophysics 4031 Via Oro Avenue P.O. Box 22709 Long Beach, CA 90801-5709 USA tel: 310-816-1600 tel: 310-513-1411 fax: 310-513-6593 Mr. Ted Tomoyasu ** Tim Gertzman ** www.egginc.com/	EG&G Astrophysics 4031 Via Oro Avenue P.O. Box 22709 Long Beach, CA 90801-5709 USA tel: 310-816-1600 tel: 310-513-1411 fax: 310-513-6593 Mr. Ted Tomoyasu ** Tim Gertzman ** www.egginc.com/	14-Jun	YES	220 Vac 50/60 Hz 10 A 380/440 Vac 3 phase 50/60 Hz 10 A	RS-232 VGA Video Ethernet 100baseT Fiber Optics	Proprietary		Z-Scan 7 Basic Specifications; July 1999. Also Web site data provided some concept of operation.	Tim Gertzman Ted Tomoyasu		
12	EG&G	Z-Scan 12	BEDS - Checked Baggage Screening	EG&G Astrophysics 4031 Via Oro Avenue P.O. Box 22709 Long Beach, CA 90801-5709 USA tel: 310-816-1600 tel: 310-513-1411 fax: 310-513-6593 Mr. Ted Tomoyasu ** Tim Gertzman ** www.egginc.com/	EG&G Astrophysics 4031 Via Oro Avenue P.O. Box 22709 Long Beach, CA 90801-5709 USA tel: 310-816-1600 tel: 310-513-1411 fax: 310-513-6593 Mr. Ted Tomoyasu ** Tim Gertzman ** www.egginc.com/	14-Jun	NO	115/230 Vac 10%. 50/60 Hz	Should be similar to Z-Scan 7 in line above	Unknown		Website data provided some pictures and concepts of operation.	Tim Gertzman Ted Tomoyasu		
13	Heimann Systems	Hi-Scan 10050 EDS	BEDS - Checked Baggage Screening	Heimann Systems Inc. 950 Bergar Laval, Quebec H7L 5A1 Canada tel: 450-967-0010 fax: 450-967-7444 Cherif Rizkatta HS-canada@heimannsystems.com	Heimann Systems GmbH Carl-von-Linde Strabe 14 65197 Weisbaden Germany tel: ++49 611 9412 0 fax: ++49 611 9412 229 www.heimannsystems.com	12-Jun	YES	4.5 kVA 208/240 Vac 50/60 Hz	RS-232 Video Connection 15 pin Ethernet 10 Mb	Proprietary		NONE for the model.	Tim Gertzman Ted Tomoyasu		
14	InVision	CTX 5000 DS	BEDS - Checked Baggage Screening/could be adapted to carry on baggage	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct :510-739-2427 Yotam Margalit Bob Madden ** robert_madden@invision.iip.com www.invision-tech.com/products/	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct: 510-739-2427 Yotam Margalit Bob Madden ** robert_madden@invision.iip.com www.invision-tech.com/products/	15-Jun	YES	350-510 Volts 3 phase, 3 wire 50/60 Hz 25 A nominal MAX 10 kVA	RS-232 VGA/EGA Video Ethernet 10MB Contact Closure Terminal I/O	Proprietary		Website data provided some pictures and concepts of operation.	Bob Madden robert_msffm@invision.iip.com		

** is main contact person for technical data

	Maker	Model	Applications	Distributed By	Manufactured By	Request Sent	Respse	Power Requirements	Interface Protocol or Connection	Data Protocol	Data Requirement Output	Manuals Received	Contact Person	Visit Date	Comment
15	InVision	CTX 5000 SP	BEDS - Checked Baggage Screening/could be adapted to carry on baggage	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct: 510-739-2427 Yotam Margalit Bob Madden ** robert_madden@invision.iip.com www.invision-tech.com/products/	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct: 510-739-2427 Yotam Margalit Bob Madden ** robert_madden@invision.iip.com www.invision-tech.com/products/	15-Jun	YES	350-510 Volts 3 phase, 3 wire 50/60 Hz 25 A nominal MAX 10 kVA	RS-232 VGA/EGA Video Ethernet 10MB Contact Closure Terminal I/O	Proprietary		Integration Guide CTX 5000SP Rev. A; 960108.	Bob Madden robert_msffm@invision.iip.com		
16	InVision	CTX 5500 DS	BEDS - Checked Baggage Screening/could be adapted to carry on baggage 2nd Generation CTX-5000	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct: 510-739-2427 Yotam Margalit Bob Madden ** robert_madden@invision.iip.com www.invision-tech.com/products/	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct: 510-739-2427 Yotam Margalit Bob Madden ** robert_madden@invision.iip.com www.invision-tech.com/products/	15-Jun	YES	350-510 Volts 3 phase, 3 wire 50/60 Hz 25 A nominal MAX 10 kVA	RS-232 VGA/EGA Video Ethernet 10MB Contact Closure Terminal I/O	Proprietary		Integration Guide CTX 5500DS Rev. A; 960182.	Bob Madden robert_msffm@invision.iip.com		
17	InVision	CTX 9000 Dsi	BEDS - Checked Baggage Screening/could be adapted to carry on baggage	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct: 510-739-2427 Yotam Margalit Bob Madden ** robert_madden@invision.iip.com www.invision-tech.com/products/	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct: 510-739-2427 Yotam Margalit Bob Madden ** robert_madden@invision.iip.com www.invision-tech.com/products/	15-Jun	NO	Unknown	RS-232 VGA/EGA Video Ethernet 10MB Contact Closure Terminal I/O	Proprietary		Website data provided some pictures and concepts of operation.	Bob Madden robert_msffm@invision.iip.com		This product is too new to have the supporting documentation available.
18	L3 Communications	eXaminer 3DX 6000	BEDS - Checked Baggage Screening	L3 Communications Security 13161 56th Court, Suite 209-210 Clearwater, FL 33760 USA tel: 727 556-0270 fax: 727 556-0271 Mr Will Jowers www.analogic.com/evel4/ www.lmco.com/ www.cassbeth.com/technology/ www.sky.com/	L3 Communications Security 13161 56th Court, Suite 209-210 Clearwater, FL 33760 USA tel: 727 556-0270 fax: 727 556-0271 Mr Will Jowers www.analogic.com/level4/ www.lmco.com/ www.cassbeth.com/technology/ www.sky.com/	9-Aug	NO	CT Scanner 208 Vac +10%-15% 3 phase 48-62 Hz 30 A Baggage Viewing Station 110/120 Vac 48-62 Hz	RS-232 FDDI 100 MB RS-422 PLC I/O	Unknown		Website data provided some pictures and concepts of operation.	Will Jowers		
19	Vivid Technologies	VIS-M Automatic Level 1	BEDS - Checked Baggage Screening	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	14-Jun	YES	100/120 Vac 10% 50/60 Hz 5 Amp MAX 220/240 Vac 10% 50/60 Hz 2.5 Amp MAX	FDDI 100 MB VGA/EGA Video	Proprietary		Vivid Corporate & Product Overview; May 1, 1997 VIS-M Matrix Functional Description; May 4, 1999.	Mr. Michael Thompson Director of Sales Vivid Technologies 993 Lenox Drive, Suite 200 Lawrenceville, NJ 08648 USA tel: 609-844-7610 fax: 609-844-7586 CellP: 609-306-2102	21 June, 1999 Visit at Telexis Corp. in Kanata.	
20	Vivid Technologies	Operator workstation Level 2	Operator Workstation	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	14-Jun	NO	220 Vac 50/60 Hz	FDDI 100 MB VGA/EGA Video	Proprietary		Vivid Corporate & Product Overview; May 1, 1997 VIS-M Matrix Functional Description; May 4, 1999.	Jim Aldo		

** is main contact person for technical data

	Maker	Model	Applications	Distributed By	Manufactured By	Request Sent	Respse	Power Requirements	Interface Protocol or Connection	Data Protocol	Data Requirement Output	Manuals Received	Contact Person	Visit Date	Comment
21	Vivid Technologies	VDS II (Operator Level 3 unit)	BEDS - Checked Baggage Screening	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	14-Jun	NO	Unknown	FDDI 100 MB VGA/EGA Video	Proprietary		Vivid Corporate & Product Overview; May 1, 1997 VIS-M Matrix Functional Description; May 4, 1999.	Jim Aldo		
22	Vivid Technologies	MVT Levels 1, 2, and 3	BEDS - Checked Baggage Screening Bulk Explosives Detection Systems	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	14-Jun	NO	Unknown	FDDI 100 MB VGA/EGA Video	Proprietary		NONE	Jim Aldo		
23	Daimler-Benz Aerospace	Radio Frequency Identification Bag Tag	Passenger Baggage Reconciliation System	Daimler-Benz Worthstrasse 85, D-89077 Ulm, Germany tel: 49 731 392 5487 fax: 49 731 392 3166	Daimler-Benz Worthstrasse 85, D-89077 Ulm, Germany tel: 49 731 392 5487 fax: 49 731 392 3166		NO	Unknown		Unknown		NONE	NONE		
24	FAG-Flughafen Main AG	FRA-BRS Passenger Baggage Reconciliation System	Passenger Baggage Reconciliation System	FAG-Flughafen Main AG Frankfurt Airport, D-60547 Frankfurt am Main Germany tel: 49 69 690 71103 fax: 49 69 690 53131	FAG-Flughafen Main AG Frankfurt Airport, D-60547 Frankfurt am Main Germany tel: 49 69 690 71103 fax: 49 69 690 53131		NO	Unknown		Unknown		NONE	NONE		
25	GEC Alsthom Engineering Systems Ltd.	Baggage Reconciliation and Handling Management System (BRAHMS)	Passenger Baggage Reconciliation System	GEC Alsthom Engineering Systems Ltd. Cambridge Road Whetstone, Leicester, LE83LH UK tel: 44 116275 0750 fax 44 116275 0787	GEC Alsthom Engineering Systems Ltd. Cambridge Road Whetstone, Leicester, LE83LH UK tel: 44 116275 0750 fax 44 116275 0787		NO	Unknown		Unknown		NONE	NONE		
26	Heimann Systems	HI-TRAX	Data Acquisition System for HI-SCAN 6040-A, HI-SCAN 6040-I, and HI-SCAN 10050 EDS	Heimann Systems Inc. 950 Bergar Laval, Quebec H7L 5A1 Canada tel: 450-967-0010 fax: 450-967-7444 Cherif Rizkatta HS-canada@heimannsystems.com	Heimann Systems GmbH Carl-von-Linde Strabe 14 65197 Weisbaden Germany tel: ++49 611 9412 0 fax: ++49 611 9412 229 www.heimannsystems.com		YES	230 Vac 50/60 Hz 0.6 kVA	Video Connection 15 pin RS-232 Ethernet 10 Mb	Proprietary		NONE	NONE		
27	BAE	JetScan	Automated Checked Baggage Sorting System	BAE Inc. 2525 Carter Drive Carrollton, TX 75006 tel: 972-245-9411 fax: 972-389-6368 Al Rollins Customer Service ** Jay Bouton ** www.bae-inc.com	BAE Inc. 2525 Carter Drive Carrollton, TX 75006 tel: 972-245-9411 fax: 972-389-6368 Al Rollins Customer Service ** Jay Bouton ** www.bae-inc.com	20-Aug	YES	100/120 Vac 10% 50/60 Hz 10 Amp MAX	Ethernet 10BaseT	Unknown		NONE	Al Rollins Jay Bouton		

** is main contact person for technical data

	Maker	Model	Applications	Distributed By	Manufactured By	Interface Type (Matrix 3)	Data Collection Speed	TX Speed	BW Required	Security	LOCAL REMOTE ACCESS	Information Management	Base Technology	Throughput
1	Garrett	Superscanner	Hand Held Metal Detector	Heimann Systems Inc. 950 Bergar Laval, Quebec H7L 5A1 Canada tel: 450-967-0010 fax: 450-967-7444 Cherif Rizkatta HS-canada@heimannsystems.com	Garrett Metal Detectors 1881 State Street Garland, TX 75042 USA tel: 214-278-6151 fax: 214-271-0186 wat: 800-234-6151 www.garrettmetaldetectors.com	Buzzer	Acoustic	N/A	audio	None	None	None	Portable Flux Gate Magnetometers	Determined by operator
							Manual	N/A	audio	None	None	None		
2	CEIA	02PN10 Security Metal Detector	Walk Through Metal Detector	CEIA USA 9177 Dutton Drive Twinsburg, OH USA tel: 330-405-3190 fax: 330-405-3196 Scott Dennisson www.ceia-usa.com	Costruzioni Elettroniche Industrial Automatismi Zona Industriale 52040 Viciomaggio (Arrezzo) Italy tel: +39 575 4181 fax: +39 575 418290	2 x RS-232	Variable rate	Variable Baud Rate	User Definable between 300 and 57600 Baud	No security on direct connection. User is limited to changing settings such as volume and this requires a pass card.	Requires MDSCOPE 4 ports in parallel	Reception Settings SE Sensitivity DS Maximum speed limit LS Minimum speed limit LC Ground level sensitivity coefficients UC Sensitivity coefficient in the highest points of the passageway NL Noise limitation Transmission Settings CH Transmission channel Alarm signal settings AD Alarm duration AV Alarm volume MV Minimum alarm volume AT Alarm Pitch RE Alarm Reset RM Mode of alarm reset Management of the walk-through metal detector BR Serial interface transmission feed (BAUD RATE) NP New password CP Chip card password AC Alarm counter or statistical analysis (mod. with photocells) NT Net ring rate threshold CR Alarm counter reset WT Total operating time of the metal detector	2 magnetic field generators Tx & Rx synchronized	Determined by operator
						Buzzer	Acoustic							
						Alarm Light	Visual							
3	Heimann Systems	HI-SCAN 6040-A	Carry-On Baggage Screening	Heimann Systems Inc. 950 Bergar Laval, Quebec H7L 5A1 Canada tel: 450-967-0010 fax: 450-967-7444 Cherif Rizkatta HS-canada@heimannsystems.com	Heimann Systems GmbH Carl-von-Linde Strabe 14 65197 Weisbaden Germany tel: ++49 611 9412 0 fax: ++49 611 9412 229 www.heimannsystems.com	1 x RS-232	9600 Baud	9600 Baud	9600 Baud	Yes, there doesn't appear to be any operator changeable settings.	YES	YES	L-shaped detector line X-ray	480 bags per hour assuming that each bag is 1 meter long and a spacing of .50 meters between bags.
4	Barringer Technologies	Ionscan 400/400B	Trace Explosives Detection System TEDS	Barringer Technologies Inc. 1730 Aimco Boulevard Mississauga, ON L4W 1V1 Canada tel: 905-238-8837 fax: 905-238-3018 Kim Lena www.barringer.com	Barringer Technologies Inc. 1730 Aimco Boulevard Mississauga, ON L4W 1V1 Canada tel: 905-238-8837 fax: 905-238-3018 www.barringer.com	2 x RS-232	2 x DB9 serial 38,400 Baud	38400 Baud	38400 Baud	Yes, 3 levels of users. Each password protected.	YES	YES	Ion Mobility Spectrometry (IMS)	300 per hour based on an average test time of 12 seconds. A typical scan takes between 6 and 18 seconds.
						Buzzer	Acoustic							
						LCD Display	Visual							
						1 x Printer Port	Printer Port							

	Maker	Model	Applications	Distributed By	Manufactured By	Interface Type (Matrix 3)	Data Collection Speed	TX Speed	BW Required	Security	LOCAL REMOTE ACCESS	Information Management	Base Technology	Throughput
5	Intelligent Detection Systems (Scintrex)	Orion Plus	Trace Explosives Detection System TEDS	Intelligent Detection Systems (Scintrex) 152 Cleopatra Drive Nepean, ON K2G 5X2 Canada tel: 613-224-1061 fax: 613-224-2603 Mr. Kalid Batar / Shelly Romain www.idsdetection.com	Intelligent Detection Systems (Scintrex) 152 Cleopatra Drive Nepean, ON K2G 5X2 Canada tel: 613-224-1061 fax: 613-224-2603 www.idsdetection.com	Floppy Disk	75 kB/sn	75 kB/sn	75 kB/sn	YES Key Lock Passwords	NO	YES	Gas Chromotography	Determine by Operator ~ 7 sec response.
6	Intelligent Detection Systems (Scintrex)	EVD-1 EVD-3000 Hand held Detector	Trace Explosives Detection System TEDS	Intelligent Detection Systems (Scintrex) 152 Cleopatra Drive Nepean, ON K2G 5X2 Canada tel: 613-224-1061 fax: 613-224-2603 Mr. Kalid Batar / Shelly Romain www.idsdetection.com	Intelligent Detection Systems (Scintrex) 152 Cleopatra Drive Nepean, ON K2G 5X2 Canada tel: 613-224-1061 fax: 613-224-2603 www.idsdetection.com	1 x RS-232	1200 Baud	1200 Baud	1200 Baud	NO	NO	YES	Thermo-Redox Detector	Determine by Operator ~ 7 sec response.
						LED's	Visual							
						Keypad								
						Acoustic Jack	Acoustic							
						External Power								
7	Ion Track Instruments	ITEMISER	Trace Explosives Detection System TEDS	Ion Track Instruments 205 Lowell Street Wilmington, MA 01887 USA tel: 978-658-3767 fax: 978 657-5954 Ms Laura Zampell www.iontrack.com	Ion Track Instruments 205 Lowell Street Wilmington, MA 01887 USA tel: 978-658-3767 fax: 978 657-5954 Ms Laura Zampell www.iontrack.com	1 x RS-232	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown		
8	Thermedics Detection	EGIS RAMPART now EGIS II	Trace Explosives Detection System TEDS	Thermedics Detection, Inc. 220 Mill Road Chelmsford, MA 01824-4178 USA tel: 978-251-2023/2000 X 2049 fax: 978-251-2010 Mr. Dan Dussault www.tdxinc.com	Thermedics Detection, Inc. 220 Mill Road Chelmsford, MA 01824-4178 USA tel: 978-251-2023/2000 X 2049 fax: 978-251-2010 Mr. Dan Dussault www.tdxinc.com	2 x RS-232 Modem Interface	9600 Baud	9600 Baud	9600 Baud	Yes, 3 levels of users. Upper Levels are password protected.	YES	YES	Chromatography	225 per hour.
9	Heimann Systems	HI-SCAN 6040-I (HI-SCAN 6040-A with HI-TRAX)	Carry-On Baggage Screening	Heimann Systems Inc. 950 Bergar Laval, Quebec H7L 5A1 Canada tel: 450-967-0010 fax: 450-967-7444 Cherif Rizkatta HS-canada@heimannsystems.com	Heimann Systems GmbH Carl-von-Linde Strabe 14 65197 Weisbaden Germany tel: ++49 611 9412 0 fax: ++49 611 9412 229 www.heimannsystems.com	2 x RS-232				Encrypted output. Decrypt software avail.	YES	YES	L-shaped detector line X-ray	480 bags per hour assuming that each bag is 1 meter long and a spacing of .50 meters between bags.
						Ethernet 10BaseT	10 Mbits/s	10 Mbits/s	10 Mbits/s		YES	YES		
10	AS&E	101ZZ	BEDS - Checked Carry-On-Baggage screening	American Science & Engineering 829 Middlesex Turnpike Bellerica, MA 01821 USA tel: 978-262-8700 fax: 978-262-8803 Ms. Nancy Babbidge www.as-e.com	American Science & Engineering 955 Massachusetts Avenue Cambridge, MA 02139 USA tel: 617-868-1600 fax: 617-	Printer Port	Printer Port	Printer Port	Printer Port	None	NO	NO	dual backscatter	1500/hr

	Maker	Model	Applications	Distributed By	Manufactured By	Interface Type (Matrix 3)	Data Collection Speed	TX Speed	BW Required	Security	LOCAL REMOTE ACCESS	Information Management	Base Technology	Throughput
11	EG&G	Z-Scan 7	BEDS - Checked Baggage Screening	EG&G Astrophysics 4031 Via Oro Avenue P.O. Box 22709 Long Beach, CA 90801-5709 USA tel: 310-816-1600 tel: 310-513-1411 fax: 310-513-6593 Mr. Ted Tomoyasu www.egginc.com/	EG&G Astrophysics 4031 Via Oro Avenue P.O. Box 22709 Long Beach, CA 90801-5709 USA tel: 310-816-1600 tel: 310-513-1411 fax: 310-513-6593 Mr. Ted Tomoyasu www.egginc.com/	Ethernet - UTP	100Mb/s	100Mb/s	100Mb/s	None	YES	YES	Dual-energy X-ray	1000 bags per hour.
12	EG&G	Z-Scan 12	BEDS - Checked Baggage Screening	EG&G Astrophysics 4031 Via Oro Avenue P.O. Box 22709 Long Beach, CA 90801-5709 USA tel: 310-816-1600 tel: 310-513-1411 fax: 310-513-6593 Mr. Ted Tomoyasu www.egginc.com/	EG&G Astrophysics 4031 Via Oro Avenue P.O. Box 22709 Long Beach, CA 90801-5709 USA tel: 310-816-1600 tel: 310-513-1411 fax: 310-513-6593 Mr. Ted Tomoyasu www.egginc.com/	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown		1000 bags per hour based on Z-Scan 7 results.
13	Heimann Systems	Hi-Scan 10050 EDS	BEDS - Checked Baggage Screening	Heimann Systems Inc. 950 Bergar Laval, Quebec H7L 5A1 Canada tel: 450-967-0010 fax: 450-967-7444 Cherif Rizkatta HS-canada@heimannsystems.com	Heimann Systems GmbH Carl-von-Linde Strabe 14 65197 Weisbaden Germany tel: ++49 611 9412 0 fax: ++49 611 9412 229 www.heimannsystems.com	Ethernet 10BaseT	user definable	user definable	user definable	Encrypted output. Decrypt software avail.	YES	YES	L-shaped detector line X-ray	1,200 bags per hour.
14	InVision	CTX 5000 SP	BEDS - Checked Baggage Screening/could be adapted to carry on baggage	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct 510-739-2427 Yotam Margalit www.invision-tech.com/products/	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct 510-739-2427 Yotam Margalit www.invision-tech.com/products/	2 x RS-232	9.6-33.6 kBaud	9.6-33.6 kBaud	9.6-33.6 kBaud	NO	YES	NO	Combination of X-ray and CT scanner	150 bags per hour in US or 240 bags per hour in Europe.
15	InVision	CTX 9000	BEDS - Checked Baggage Screening/could be adapted to carry on baggage	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct 510-739-2427 Yotam Margalit www.invision-tech.com/products/	InVision Technologies Inc. 7151 Gateway Boulevard Newark, CA 94560 USA tel: 510 739-2400 fax: 510-608-0768 tel direct 510-739-2427 Yotam Margalit www.invision-tech.com/products/	Ethernet	10Mbit/s	10Mbit/s	10Mbit/s	Unknown	YES	N		542 bags per hour.
16	L3 Communications	eXaminer 3DX 6000	BEDS - Checked Baggage Screening	L3 Communications Security 13161 56th Court, Suite 209 Clearwater, FL 33760 USA tel: 727 556-0270 fax: 727 556-0271 www.analogic.com/level4/ www.lmco.com/ www.cassbeth.com/technology/ www.sky.com/	L3 Communications Security 13161 56th Court, Suite 209 Clearwater, FL 33760 USA tel: 727 556-0270 fax: 727 556-0271 www.analogic.com/level4/ www.lmco.com/ www.cassbeth.com/technology/ www.sky.com/	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Rotary Scanning Array	400 bags per hour.
17	Vivid Technologies	VIS-M Automatic Level 1	BEDS - Checked Baggage Screening	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	FDDI	100 Mbit/s	100 Mbit/s	100 Mbit/s	Settings are key card protected	Yes through the RS-232 and/or RS-232 ports	YES	Dual-energy X-ray	1500 bags per hour.

	Maker	Model	Applications	Distributed By	Manufactured By	Interface Type (Matrix 3)	Data Collection Speed	TX Speed	BW Required	Security	LOCAL REMOTE ACCESS	Information Management	Base Technology	Throughput
18	Vivid Technologies	Operator workstation Level 2	Operator Workstation	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	FDDI	100 Mbit/s	100 Mbit/s	100 Mbit/s	Settings are key card protected	YES	YES	Dual-energy X-ray	Determined by operator.
19	Vivid Technologies	VDS II (Operator Level 3 workstation)	BEDS - Checked Baggage Screening	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	FDDI	100 Mbit/s	100 Mbit/s	100 Mbit/s	Settings are key card protected	YES	YES	Dual-energy X-ray	Determined by operator.
20	Vivid Technologies	MVT Levels 1, 2, and 3	BEDS - Checked Baggage Screening Bulk Explosives Detection Systems	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	Vivid Technologies, Inc. 10E Commerce Way Woburn, MA 01801 USA tel: 781-938-7800 fax: 781-939-3996 fax: 781-939-3993 Mr Jim Aldo & Mr Michael Elenbogen www.vividusa.com	FDDI	100 Mbit/s	100 Mbit/s	100 Mbit/s	Settings are key card protected	Unknown	Unknown		
21	Daimler-Benz Aerospace	Radio Frequency Identification Bag Tag	Passenger Baggage Reconciliation System	Daimler-Benz Worthstrasse 85, D-89077 Ulm, Germany tel: 49 731 392 5487 fax: 49 731 392 3166	Daimler-Benz Worthstrasse 85, D-89077 Ulm, Germany tel: 49 731 392 5487 fax: 49 731 392 3166	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown		
22	FAG-Flughafen Main AG	FRA-BRS Passenger Baggage Reconciliation System	Passenger Baggage Reconciliation System	FAG-Flughafen Main AG Frankfurt Airport, D-60547 Frankfurt am Main Germany tel: 49 69 690 71103 fax: 49 69 690 53131	FAG-Flughafen Main AG Frankfurt Airport, D-60547 Frankfurt am Main Germany tel: 49 69 690 71103 fax: 49 69 690 53131	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown		
23	GEC Alsthom Engineering Systems Ltd	Baggage Reconciliation and Handling Management System (BRAHMS)	Passenger Baggage Reconciliation System	GEC Alsthom Engineering Systems Ltd. Cambridge Road Whetstone, Leicester, LE83LH UK tel: 44 116275 0750 fax 44 116275 0787	GEC Alsthom Engineering Systems Ltd. Cambridge Road Whetstone, Leicester, LE83LH UK tel: 44 116275 0750 fax 44 116275 0787	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown		
24	Heimann Systems	Hi-TRAX	BEDS - Checked Baggage Screening	Heimann Systems Inc. 950 Berger Laval, Quebec H7L 3A1 Canada tel: 450-967-0010 fax: 450-967-7444 Cheril Ricketts HS-canada@heimannsystems.com	Heimann Systems GmbH Carl-von-Linde Strabe 14 65197 Wiesbaden Germany tel: ++49 611 9412 0 fax: ++49 611 9412 229 www.heimannsystems.com	Ethernet 10BaseT	10MBits/s	10MBits/s	10MBits/s	Encrypted output. Decrypt software avail.	YES	YES	L-shaped detector line X-ray	480 bags per hour assuming that each bag is 1 meter long and a spacing of .30 meters between bags.
25	BAE Inc	Jet Scan	Baggage Tag Scanner System	BAE Inc. 2525 Carter Drive Carrollton, Texas 75006 tel: 972-245-8411 fax: 972-389-6368 www.bae-inc.com	BAE Inc. 2525 Carter Drive Carrollton, Texas 75006 tel: 972-245-8411 fax: 972-389-6368 www.bae-inc.com	Ethernet 10BaseT	10 Mb/sec	10 Mb/sec	10 Mb/sec	Possible encryption in the database where results are stored.	through network	YES	Optical barcode scanner	4800 bags per hour.

	Maker	Model	Applications	Distributed By	Manufactured By	Interface Type (Matrix 3)	Data Collection Speed	TX Speed	BW Required	Security	LOCAL REMOTE ACCESS	Information Management	Base Technology	Throughput
26	Intelligent Detection Systems (Scintrex)	EVD-1 OBSOLETE	Trace Explosives Detection System TEDS	Intelligent Detection Systems (Scintrex) 152 Cleopatra Drive Nepean, ON K2G 5X2 Canada tel: 613-224-1061 fax: 613-224-2603 Mr. Kalid Batar / Shelly Romain www.idsdetection.com	Intelligent Detection Systems (Scintrex) 152 Cleopatra Drive Nepean, ON K2G 5X2 Canada tel: 613-224-1061 fax: 613-224-2603 www.idsdetection.com									

	Maker	Model	Applications	Distributed By	Manufactured By	Interface Type (Matrix 3)	Data Collection Speed	TX Speed	BW Required	Security	LOCAL REMOTE ACCESS	Information Management	Base Technology	Throughput

	Maker	Model	Applications	STORAGE Short Term	STORAGE Long Term	Special Functions	DATA Processing	MANIPULATION le Force Level II	DATA Verification	OPERATIONAL Considerations	HUMAN FACTORS ENGINEERING	Interfaces see Matrix3
1	Garrett	Superscanner	Hand Held Metal Detector	NO	NO	None	NO	NO	None	None	None	Audio
2	CEIA	02PN10 Security Metal Detector	Walk Through Metal Detector	NO	NO	None	NO	NO	None	None	None	2 x RS-232
3	Heimann Systems	HI-SCAN 6040-A	Carry-On Baggage Screening	YES	Optional	YES optional hardware permits long-term storage of data	YES	NO	None	None	None	RS-232 & Diagnostics
4	Barringer Technologies	Ionscan 400/400B	Trace Explosives Detection System TEDS	NO	NO	None	YES	NO	None	None	None	2 x DB-9 1 x DB-25
5	Intelligent Detection Systems (Scintrex)	Orion Plus	Trace Explosives Detection System TEDS	YES	YES If retrieved by Floppy Disk	YES If data is exported to floppy disk	YES	NO	None	None	Touch Screen	None
6	Intelligent Detection Systems (Scintrex)	EVD-1 EVD-3000 Hand held Detector	Trace Explosives Detection System TEDS	YES	YES If retrieved by Floppy Disk	YES Export of data to floppy disk	YES	NO	None	None	None	1 x DB-9
7	Ion Track Instruments	ITEMISER	Trace Explosives Detection System TEDS	YES If retrieved by an external system running win 98	YES If retrieved by an external system running win 98	YES Information accessible through a computer running Windows 98.	YES	NO	None	Requires Win98 for data export	None	Unknown
8	Thermedics Detection	EGIS RAMPART now EGIS II	Trace Explosives Detection System TEDS	YES	YES If retrieved through modem port	None	YES	YES	YES If Retrieved through Modem Port	None	None	2 x DB-9 (Modem opt)
9	Heimann Systems	HI-SCAN 6040-I (HI-SCAN 6040-A with HI-TRAX)	Carry-On Baggage Screening	YES	Optional	YES Long-term storage requires that information be removed from the short-term storage and stored elsewhere	YES	NO	None	None	None	1 x RS-232-M22Diagnostics
10	AS&E	101ZZ	BEDS - Checked Carry-On-Baggage screening	NO	NO	None	YES	NO	None	None	None	1 x DB-25
11	EG&G	Z-Scan 7	BEDS - Checked Baggage Screening	YES 100 images	YES If retrieved from system	None	YES	YES	None	None	None	Ethernet - UTP

	Maker	Model	Applications	STORAGE Short Term	STORAGE Long Term	Special Functions	DATA Processing	MANIPULATION le Force Level II	DATA Verification	OPERATIONAL Considerations	HUMAN FACTORS ENGINEERING	Interfaces see Matrix3
12	EG&G	Z-Scan 12	BEDS - Checked Baggage Screening	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	None	None	Unknown
13	Heimann Systems	Hi-Scan 10050 EDS	BEDS - Checked Baggage Screening	YES	Optional	YES Long-term storage requires that information be removed from the short-term storage and stored elsewhere	YES	YES	None	None	None	Ethernet 10BaseT
14	InVision	CTX 5000 SP	BEDS - Checked Baggage Screening/could be adapted to carry on baggage	YES	YES	None	YES	YES	None	None	None	Unknown
15	InVision	CTX 9000	BEDS - Checked Baggage Screening/could be adapted to carry on baggage	YES	YES	Unknown	YES	YES	None	None	None	Ethernet
16	L3 Communications	eXaminer 3DX 6000	BEDS - Checked Baggage Screening	Unknown	Unknown	None	YES	YES	None	None	None	Unknown
17	Vivid Technologies	VIS-M Automatic Level 1	BEDS - Checked Baggage Screening	YES	YES If retrieved by an external system	YES MIS Bridge forwards all relevant status data to the airport MIS	YES	YES	None	Limited Distance 50m cable run. Full fiber optic redundancy avail.	Touch Screen	FDDI
18	Vivid Technologies	Operator workstation Level 2	Operator Workstation	YES	YES If retrieved by an external system	Unknown	YES	YES	None	None	None	FDDI
19	Vivid Technologies	VDS II (Operator Level 3 workstation)	BEDS - Checked Baggage Screening	YES	YES If retrieved by an external system	Unknown	YES	YES	None	None	None	FDDI
20	Vivid Technologies	MVT Levels 1, 2, and 3	BEDS - Checked Baggage Screening Bulk Explosives Detection Systems	YES	YES If retrieved by an external system	Unknown	YES	YES	Unknown	None	None	FDDI
21	Daimler-Benz Aerospace	Radio Frequency Identification Bag Tag	Passenger Baggage Reconciliation System	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	None	None	Unknown
22	FAG-Flughafen Main AG	FRA-BRS Passenger Baggage Reconciliation System	Passenger Baggage Reconciliation System	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	None	None	Unknown

	Maker	Model	Applications	STORAGE Short Term	STORAGE Long Term	Special Functions	DATA Processing	MANIPULATION le Force Level II	DATA Verification	OPERATIONAL Considerations	HUMAN FACTORS ENGINEERING	Interfaces see Matrix3
23	GEC Alsthom Engineering Systems Ltd.	Baggage Reconciliation and Handling Management System (BRAHMS)	Passenger Baggage Reconciliation System	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	None	None	Unknown
24	Heimann Systems	HI-TRAX	BEDS - Checked Baggage Screening	YES	Optional	YES Long-term storage requires that information be removed from the short-term storage and stored elsewhere	YES	NO	NO	None	None	Ethernet 10BaseT
25	BAE Inc	Jet Scan	Baggage Tag Scanner System	YES	YES If externally extracted	YES Search Data Base	YES	NO	YES	None	None	Ethernet 10Base

Existing Airport Security Equipment DATA PROCESSING/STORAGE Functions

	Maker	Model	Applications	STORAGE Short Term	STORAGE Long Term	Special Functions	DATA Processing	MANIPULATION ie Force Level II	DATA Verification	OPERATIONAL Considerations	HUMAN FACTORS ENGINEERING	Interfaces see Matrix3

	Maker	Model	Applications	PHYSICAL BAGGAGE MAXIMUM SIZE cm	PHYSICAL UNIT SIZE cm	DATA PROTOCOL	ELECTRICAL INTERFACE	LOGICAL INTERFACE	ENVIRONMENTAL LIMITATIONS	PROBLEM DESCRIPTION	SOLUTION DESCRIPTION	NOTES	PINOUTS	COMMUNICATIONS SETUP
1	Garrett	Superscanner	Hand Held Metal Detector	N/A	8 x 4 x 42 (3.25 x 1.625 x 16.5 in)	None	Buzzer	Audio	-10C to +50C 0 to 95% non-condensing			Possible RF connection could be made		
							Jack for Earphone	Audio						
2	CEIA	02PN10 Security Metal Detector	Walk Through Metal Detector	76.0 x 20.50	87.5 x 68.0 x 223.5	None	2 x RS-232C	2 x DB-9	Temp -10C - 50C Humidity 10-90% non-condensing		Interrogation session can be used to retrieve data and program metal detectors. Programming codes are on page 158 of the manual.	Possible contact closures.	DB-9 on detector 2 Data in 3 Data out 5 Ground	VT100, 8-N-1 300 to 57600 9600 default
							Buzzer	Audio						
							Passenger signaling light	alarm signal-RED						
							Relay contact NO	Type C NO						
							Relay contact NO	Type C NO						
							LED's	4 green 8 red BAR graph display						
							Keyboard							
							Chip Card reader							
							Communications unit (opt)							
3	Heimann Systems	HI-SCAN 6040-A	Carry-On Baggage Screening	60.0 x 40.0	200.6 x 83.3 x 123.6	Proprietary, conversion package may be avail.	1 x RS-232 Diagnostics	1 x DB-25	Temp 0C - 40C Humidity 10-90% non-condensing		A video capture card can be connected to the VGA connector. This will allow us to save the image in any format.	Resolution is 684x576 pixels. Output is of form R,G+SYNC,B,CVS The RS-232 port can only be used for diagnostics	DB-25 on 6040A 3 -TXD 2 -RxD 7 -GND	VT100 9600 baud 8-N-1 no flow control
							VGA Video							
							Add-on box stores images in standard format							
							PC Store (training)							
							Alarm Buzzer							
							Linkin/Linkout							
							Monitor adapter for multiple monitors							
4	Barringer Technologies	Ionscan 400/400B	Trace Explosives Detection System TEDS	N/A	41 x 34 x 33	Proprietary	2 x RS-232	2 x DB-9	Temp 0 - 40C Humidity 10-95% non-condensing		Printer can be set to print every result. Management software can be configured to export a file when an alarm is triggered. All relevant data from the scan is in this file. The modem port can only export the data at the end of the day.	1 x DB-9 connection for a computer second for an optional modem 1 x DB-25 for printer. Ionscan unit must be setup to print all images. Possible contact closures.		
							1 x Printer port	1 x DB-25						
							LED's							
							alarms							
							4 colour LCD Display							
5	Intelligent Detection Systems (Scintrex)	Orion Plus	Trace Explosives Detection System TEDS	N/A	100 x 67 x 52	None	None	Unknown	Temp 0 - 40C Humidity 10-90% non-condensing					
6	Intelligent Detection Systems (Scintrex)	EVD-1 EVD-3000 Hand held Detector	Trace Explosives Detection System TEDS	N/A	51 x 14 x 11	None	1 x RS-232	1 x DB-9	Temp -5 - 55 C op -5 - 65 C store <90% non-condensing					1200 Baud 7 data bits 2 stop Handshake - None Parity - None
							LED's							

	Maker	Model	Applications	PHYSICAL BAGGAGE MAXIMUM SIZE cm	PHYSICAL UNIT SIZE cm	DATA PROTOCOL	ELECTRICAL INTERFACE	LOGICAL INTERFACE	ENVIRONMENTAL LIMITATIONS	PROBLEM DESCRIPTION	SOLUTION DESCRIPTION	NOTES	PINOUTS	COMMUNICATIONS SETUP
7	Ion Track Instruments	ITEMISER	Trace Explosives Detection System TEDS	N/A	Unknown	None	1 x RS-232	1 x DB-9	Unknown					
8	Thermedics Detection	EGIS RAMPART now EGIS II	Trace Explosives Detection System TEDS	N/A	74 x 48 x 30 (29 x 19 x 12 in)	DOS 6.22 Interlink function	2 x RS-232 (optional Modem)	2 x DB-9	Temp 0 - 40C Humidity 0-90% non-condensing		Possibility of capturing data through the printer port as all results can be printed. It may be a proprietary printer model as it is supposed to support a EGIS II printer	EGIS II unit must be setup to print all images. All data can be saved to a hard disk.		
							Optional Modem				A slot modem avail for unit and through this the HD can be accessed. By a software change, an alert can be issued and relevant data transmitted to a defined destination. Thermedics can make these changes. Custom software modes can be implemented.			
							1 x Printer port	1 x DB-25						
							LED's - alarm							
							Display							
							Alarm on keypad							
9	Heimann Systems	HI-SCAN 6040-I (HI-SCAN 6040-A with HI-TRAX)	Carry-On Baggage Screening	60.0 x 40.0	200.6 x 83.3 x 123.6	Proprietary, conversion package may be avail.	1 x RS-232C- diagnostics	1 x DB-25	Temp 0 - 40C Humidity 10-90% non-condensing			The RS-232 port can only be used for diagnostics.		
							VGA							
							Ethernet 10BaseT							
10	AS&E	101ZZ	BEDS - Checked Carry-On-Baggage screening	52 x 81.9 x unlimited	124 x 262 x 157	Proprietary	1 x printer port	1 x DB-25	Temp -4C to +40C Humidity 20-90% non-condensing			512 x 512 resolution 256 shades of Grey.		
							VCR - composite video							
							floppy drive							
11	EG&G	Z-Scan 7	BEDS - Checked Baggage Screening	80 x 102 x 300	267 x 188 x 86 (105 x 74 x 34 in)	Unknown	Ethernet - UTP	Unknown	Unknown			Workstation converts from 12 bit colour to 24 bit colour. 1280x1024 resolution		
							Ethernet - fiberoptic							
							1 x Serial I/O							
							VGA							
							PLC							
12	EG&G	Z-Scan 12	BEDS - Checked Baggage Screening	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown					
13	Heimann Systems	Hi-Scan 10050 EDS	BEDS - Checked Baggage Screening	10.0 x 50.0	Unknown	Proprietary, conversion package avail.	Ethernet 10Base	User definable	Temp 0 - 40C Humidity 10-90% non-condensing		The HI-SCAN 10050EDS dumps all images automatically to the standard off the shelf PC directly connected to it. Any network card could be put into that computer to allow access to the data.	The RS-232 port can only be used for diagnostics		

	Maker	Model	Applications	PHYSICAL BAGGAGE MAXIMUM SIZE cm	PHYSICAL UNIT SIZE cm	DATA PROTOCOL	ELECTRICAL INTERFACE	LOGICAL INTERFACE	ENVIRONMENTAL LIMITATIONS	PROBLEM DESCRIPTION	SOLUTION DESCRIPTION	NOTES	PINOUTS	COMMUNICATIONS SETUP
							VGA							
14	InVision	CTX 5000 SP	BEDS - Checked Baggage Screening/could be adapted to carry on baggage	99 x 64 x 51 (39 x 25 x 20 in)	277 x 224 x 241 (109 x 88 x 95 in)	Proprietary	2 x RS-232	Unknown	Temp 10 - 35C Humidity 10-80% non-condensing			128 Grey + colour 800x600 resolution		
							VGA							
							console interface							
							contact closures - 64							
15	InVision	CTX 9000	BEDS - Checked Baggage Screening/could be adapted to carry on baggage	17 x 99 x 43 (46 x 39 x 17 in)	486 x 241 x 226 (191 x 95 x 89 in)	Proprietary	Ethernet	Unknown	Temp -7 - 49C Humidity 0-99% non-condensing			1024x768 resolution		
							VGA							
16	L3 Communications	eXaminer 3DX 6000	BEDS - Checked Baggage Screening	75 x 63 x 137	219 x 206 x 220	Unknown	Unknown	Unknown	Temp +10C to +40C operating -20C to +70C shipping					
17	Vivid Technologies	VIS-M Automatic Level 1	BEDS - Checked Baggage Screening	1250 cm max length	Unknown	Proprietary	FDDI	Unknown	Unknown					
							1 x RS-232 only on network bridge							
							RS-422 only on network bridge							
							PLC interface (add on)							
18	Vivid Technologies	Operator workstation Level 2	Operator Workstation	N/A	Unknown	Proprietary	FDDI	Unknown	Unknown			1280x1024 resolution 256 colours		
							VGA							
19	Vivid Technologies	VDS II (Operator Level 3 workstation)	BEDS - Checked Baggage Screening	N/A	Unknown	Proprietary	FDDI	Unknown	Unknown			1280x1024 resolution 256 colours		
							VGA							
20	Vivid Technologies	MVT Levels 1, 2, and 3	BEDS - Checked Baggage Screening Bulk Explosives Detection Systems	N/A	Unknown	Proprietary	FDDI	Unknown	Unknown					
21	Daimler-Benz Aerospace	Radio Frequency Identification Bag Tag	Passenger Baggage Reconciliation System	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown					
22	FAG-Flughafen Main AG	FRA-BRS Passenger Baggage Reconciliation System	Passenger Baggage Reconciliation System	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown					
23	GEC Alsthom Engineering Systems Ltd.	Baggage Reconciliation and Handling Management System (BRAHMS)	Passenger Baggage Reconciliation System	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown					
24	Heimann Systems	HI-TRAX	BEDS - Checked Baggage Screening	60.0 x 40.0	Unknown	Proprietary, conversion package avail.	Ethernet 10BaseT	RJ-45	Temp 0 - 40C Humidity 0-95% non-condensing		The Ethernet card will allow us to read the file from the HI-TRAX system automatically. All images are saved to disk.			
							VGA							

	Maker	Model	Applications	PHYSICAL BAGGAGE MAXIMUM SIZE cm	PHYSICAL UNIT SIZE cm	DATA PROTOCOL	ELECTRICAL INTERFACE	LOGICAL INTERFACE	ENVIRONMENTAL LIMITATIONS	PROBLEM DESCRIPTION	SOLUTION DESCRIPTION	NOTES	PINOUTS	COMMUNICATIONS SETUP
25	BAE Inc	Jet Scan	Baggage Tag Scanner System	122 cm (4 foot) foot radius around baggage conveyor	122 cm (4 foot) foot radius around baggage conveyor	Ethernet 10BaseT	UTP	Ethernet	Unknown likely indoor		The Jetscan unit accurately scans the luggage tag on 97%+ of the baggage. The tag is placed on the handle of the luggage. When a misread or lack of tag occurs the luggage is sent to a human operated line for corrective action.	Once the bag is scanned it is then routed to the appropriate destination. This happens through communication with the airport baggage PLC. Overall, the tag scanner reads about 70% of passing tags because of bag orientation, lost or hidden tags etc.		